衞生防護中心
Centre for Health Protection

# Scientific Committee on Enteric Infections and Foodborne Diseases

## Review of Staphylococcal Food Poisoning in Hong Kong

### Purpose

This paper reviews the latest global and local epidemiology of staphylococcal food poisoning and examines the public health measures for prevention and control the disease.

### Bacteriology

2. *Staphylococcus aureus* is a non-motile facultative anaerobic Gram-positive coccus. Cells are spherical single and often form grape-like clusters. The organism produces catalase and coagulase. The staphylococcal cell wall is resistant to lysozyme and sensitive to lysostaphin, which specifically cleaves the pentaglycin bridges of *Staphylococcus spp*. The organisms are able to grow in a wide range of temperatures (7°C to 48°C with an optimum of 30°C to 37°C), pH (4.2 to 9.3, with an optimum of 7.0 to 7.5); and sodium chloride concentrations (up to 15% NaCl). These characteristics enable the bacteria to survive in a wide variety of foods, especially those require manipulation during processing, including fermented food products like cheeses (1).

3. Some *S. aureus* strains are able to produce staphylococcal enterotoxins (SEs) and are the causative agents of staphylococcal food poisoning. To date, 21 SEs have been described, with some of them proven to be emetic (1-3). The SEs are short proteins (from 194 to 245 aa) which are soluble in water. They are highly stable, resist most proteolytic enzymes, such as pepsin or trypsin, and thus keep their activity in the digestive tract after ingestion (3). Besides, enterotoxins are highly heat resistant and remain stable at 100°C for 30 minutes. Thus reheating a food product contaminated with enterotoxin-producing staphylococci will not be protective (4).

4. Staphylococcal food poisoning frequently involves foods that require considerable handling during preparation and that are kept at slightly elevated temperatures after preparation (1). In most of the time the contaminated foodstuff reaches a temperature that allows *S. aureus* growth because of a failure in the refrigeration process, or because a growth permissive temperature is required during the processing, for instance, cheese making.

5. *S. aureus* colonizes in 30% to 50% of healthy human population (5), and the anterior nares of the nose are the most frequent carriage site for the bacteria (6). In the National Health and Nutrition Examination Survey conducted in 2001-2002 in the United States, it was estimated that nearly one third (32.4%) of the non-institutionalized population including children and adults were nasal carrier (7). Prevention of staphylococcal food poisoning from the infected food handlers may be difficult as carriers are asymptomatic (4,8). Other studies also reported high prevalence of enterotoxin-producing *S. aureus* in food handlers. A cross-sectional study conducted among 127 food handlers working in cafeterias in Ethiopia indicated that 16.5% of fingernail contents of the food handlers were cultured positive for *S. aureus* (9). Another study done in Botswana reported that an even higher proportion (57.5% out of 200 food handlers) was tested positive for *S. aureus* (10).

## Clinical Presentation, Laboratory Diagnosis and Patient Management

6. Staphylococcal food poisoning is caused by the SEs in the contaminated food. The incubation period of illness ranges from 30 minutes to 8 hours, but usually 2-4 hours (11). The onset of symptoms depends on susceptibility to the SEs, the amount of contaminated food eaten, the amount of toxin in the food ingested and the general health of the patients.

7. The main symptoms are nausea, vomiting, retching, abdominal cramping and prostration, often accompanied by diarrhoea and sometimes fever. In severe cases, patients may present with headache, muscle cramping, severe fluid and electrolytes loss with weakness and low blood pressure or shock. Patients usually recover within two days, but can take longer in severe cases

that may require hospitalization. Death following a case of staphylococcal food poisoning is very rare and may occur among the elderly, infants, and severely debilitated persons.

8. The short incubation period, brevity of illness and usual lack of fever help distinguish staphylococcal intoxication from other types of food poisoning such as *Vibrio parahaemolyticus* or *Salmonella spp*. Diagnosis is easier when a group of cases presents the characteristic acute, predominantly upper gastrointestinal symptoms which occur shortly after consumption of a common high risk food.

9. The clinical suspicion can be supported by laboratory tests including isolation of *S. aureus* and detection of enterotoxins from food remnant. These laboratory tests are available at the Public Health Laboratory Branch of the Centre for Health Protection. The Centre has been testing food samples for staphylococcal enterotoxins A, B, C and D. In an outbreak investigation, molecular typing tests such as pulsed-field gel electrophoresis (PFGE) and sequencing analysis can provide evidence for epidemiological linkage between cases.

10. For most patients, staphylococcal food poisoning is self-limiting within 24-48 hours. Supportive therapy such as resting and fluid replacement using oral rehydration fluids will be sufficient. Anti-spasmodic and anti-emetics may be considered to help control symptoms of vomiting. For patients who are highly susceptible to severe fluid and electrolytes loss, they may require hospital care and intravenous fluid replacement. Antibiotics are not useful in treating staphylococcal food poisoning as the toxin is not affected by antibiotics.

## Overseas Epidemiological Situation

11. Staphylococcal food poisoning is one of the common causes of the foodborne illnesses in many parts of the world. In the United States, latest available data on foodborne disease outbreaks reported by the Centre for Disease Control and Prevention showed that *S. aureus,* together with Shiga toxin-producing *Escherichia coli,* ranked as the third commonest bacterial causative agents (9.8%), following *Salmonella* (39.7%) and *Clostridium perfringens* (11.5%) (12). The disease burden attributed by *S. aureus* seemed to become smaller when compared with the mean annual total for the previous 5 years (15.0%), though it was similar to that for 1998 to 2002 (8.5%) (13).

12. The latest report produced by European Food Safety Authority, which received data from 27 European Union Member States, showed that *S. aureus* was the fourth most common causative agent for the reported foodborne outbreaks in 2008, following *Salmonella*, foodborne viruses and

*Campylobacter* (14). *S. aureus* caused 291 foodborne outbreaks which constituted 5.5% of total number of reported outbreaks in the European Union. However, it should be noted that there might be reporting bias since France and Germany already accounted for over 40% of all outbreaks in the European Union. In England and Wales, *S. aureus* attributed to only 1.5% of all outbreaks (N = 2530) from 1992 to 2009 and ranked as the sixth most common bacterial causes during this period (15).

13. In Japan, large scale outbreaks of staphylococcal food poisoning had been reported in the past. In 2000, an extensive staphylococcal outbreak occurred in Kansai district affecting as many as 13,420 people (16). Investigation reviewed that the incriminated food was the dairy products produced by a factory in Hokkaido which experienced a transient shortage of power supply during the manufacturing process. According to the statistics published by the Ministry of Health, Labour and Welfare, 536 bacterial food poisoning outbreaks were recorded in 2009 and 7.6% of the incidents were caused by *S. aureus*, affecting 690 persons (17).

14. Apart from the outbreak in Japan, large scale outbreaks has been reported in other countries in past decades. In Brazil, a massive staphylococcal food poisoning incident affecting about 4,000 patients was reported in 2004 (18). The food prepared for the gathering was found to be contaminated by food handlers who were cultured positive for enterotoxigenic *S. aureus* from their nasophyarynx and fingernail swabs. In another outbreak of gastroenteritis reported in the United States in 1988, more than 850 students were affected in a school district. Investigation reviewed that the source of the outbreak was chocolate milk containing the SE (19).

15. The frequently incriminated foods include meat and meat products; poultry and egg products; salads; cream-filled pastries; sandwich fillings; and milk and dairy products (20). However, the foods most often involved in outbreaks differ widely from one country to another because of the variation in food consumption and habits. For example, in England and Wales, 60% of the staphylococcal food poisoning outbreak reports recorded between 1992 and 2009 were due to poultry meat and red meat (15). On the contrary, in Japan, 36% of the staphylococcal food poisoning outbreaks reported between 1995 and 1999 were due to grains like rice balls and composite ready-to-eat food, 5.6% of the incidents were due to fish and shellfish, and less than 1% was due to milk products (21).

## Local situation

16. In Hong Kong, food poisoning is a statutory notifiable disease under Prevention and Control of Disease Ordinance (Cap 599). An outbreak of food poisoning is defined as an incident in which two or more persons

experience a similar illness after ingestion of a common food, and epidemiological analysis implicates the food as the source of the illness. A staphylococcal food poisoning outbreak is classified as confirmed if the food poisoning organism or toxin is detected from clinical specimen of patient who has compatible clinical presentation or from epidemiologically implicated food specimen (e.g. food remnant or sample from the same batch of food). In addition, a food poisoning outbreak epidemiologically linked to a confirmed case is also classified as confirmed.

17. Since 2007, more stringent laboratory criteria were adopted for confirmation of staphylococcal food poisoning, which were based on overseas guidelines for confirmation of *S. aureus* foodborne outbreaks (22) (see Appendix 1 for details). In this paper, we reviewed the local epidemiology of food poisoning outbreaks associated with *S. aureus* reported to the Department of Health (DH) from 2001 to 2009.

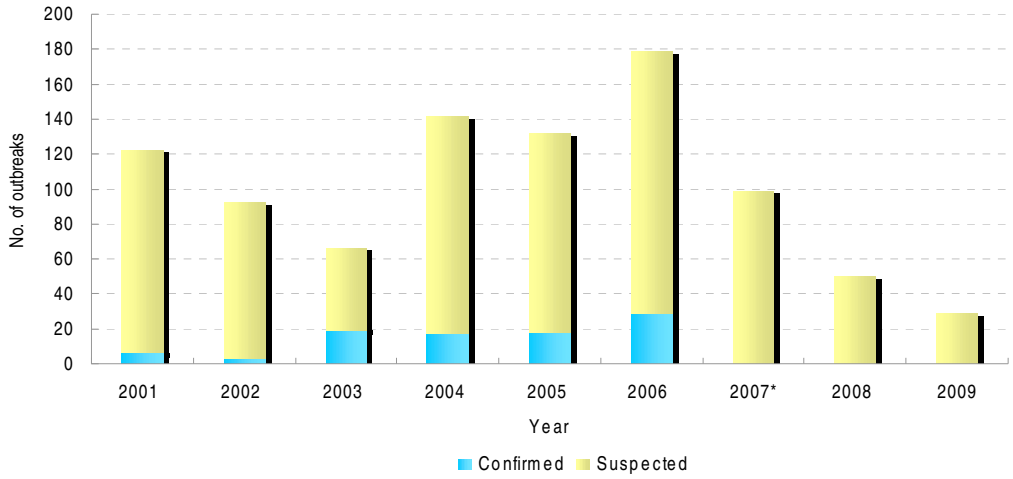
18. A total of 6,300 food poisoning outbreaks were notified to DH from 2001 to 2009. The number of food poisoning outbreaks increased steadily from 2003 to 2006 and then decreased afterwards (Figure 1). Among these outbreaks, 77.9% were caused by bacteria, followed by viruses (10.5%) and biochemicals (6.6%).

Figure 1. Number of food poisoning outbreaks notified to DH, 2001-2009

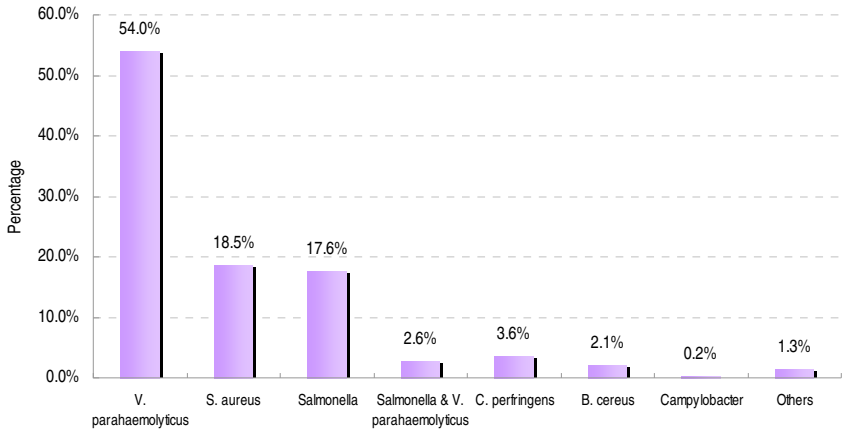

19. Only a small proportion (10.1%) of 910 outbreaks suspected to be associated with *S. aureus* were confirmed according to the aforementioned definition. It was noted that confirmation of staphylococcal food poisoning was often difficult due to lack of clinical specimen taken from patients or lack of food remnant left for examination, despite that the clusters of patients present with compatible symptoms after consumption of certain high risk food items. For example, among the suspected outbreaks only 15.3% had stool specimen of patients taken while 3.9% had food remnant taken for examination.

Hence the following analysis includes both confirmed and suspected cases to give more comprehensive epidemiological information.

20. During 2001 to 2009, a total of 910 food poisoning outbreaks attributed to *S. aureus*, affecting a total of 3,049 persons (Figure 2). They accounted for 18.5% of food poisoning outbreaks associated with bacteria causes, ranking *S. aureus* the third commonest food poisoning outbreaks agent following *V. parahaemolyticus* and *Salmonella* (Figure 3).




*Since 2007, more stringent criteria were adopted for confirmation of food poisoning associated with *S. aureus* (Appendix 1)




21. The seasonal pattern of staphylococcal food poisoning outbreaks is shown in figure 4. More outbreaks were reported from July to September and December to February. Most (93.6%) of the outbreaks affected 5 persons or below, 12.1% of the outbreaks affected 21 persons or above while the largest one affecting 102 persons. Although the number of staphylococcal food

poisoning outbreaks has been decreasing over the past few years, large food poisoning outbreaks (more than 20 persons affected) still occurred occasionally (Figure 5).

Figure 4. Number of food poisoning outbreaks associated *S. aureus* by the month of notification, 2001-2009

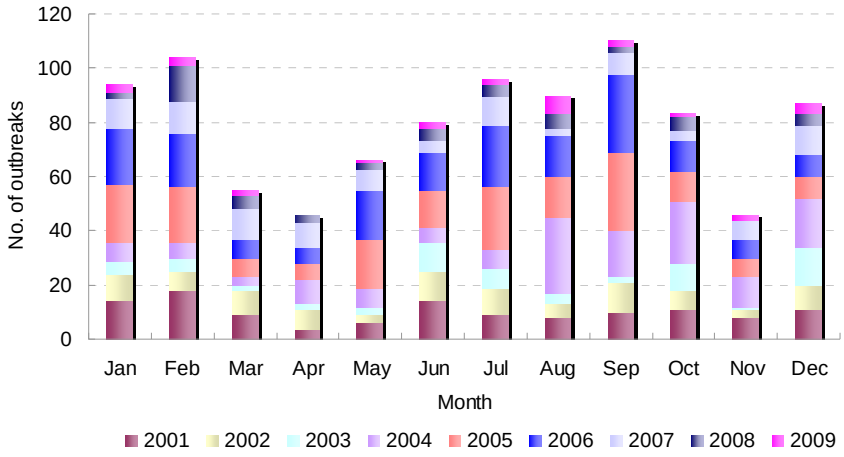
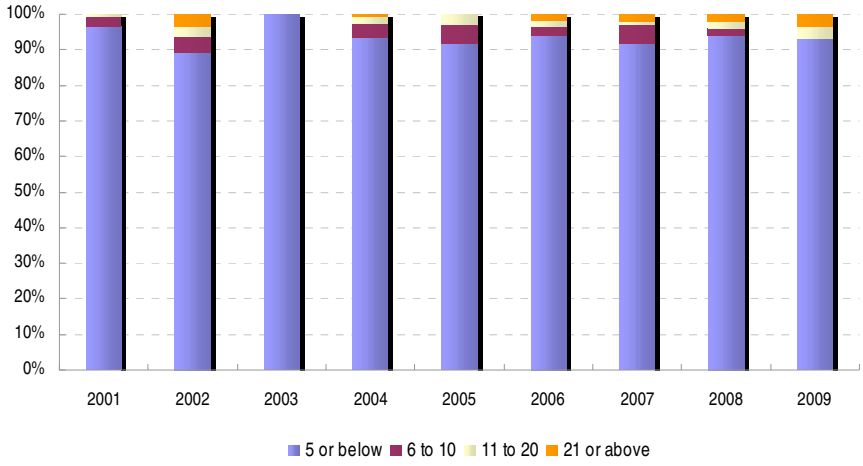
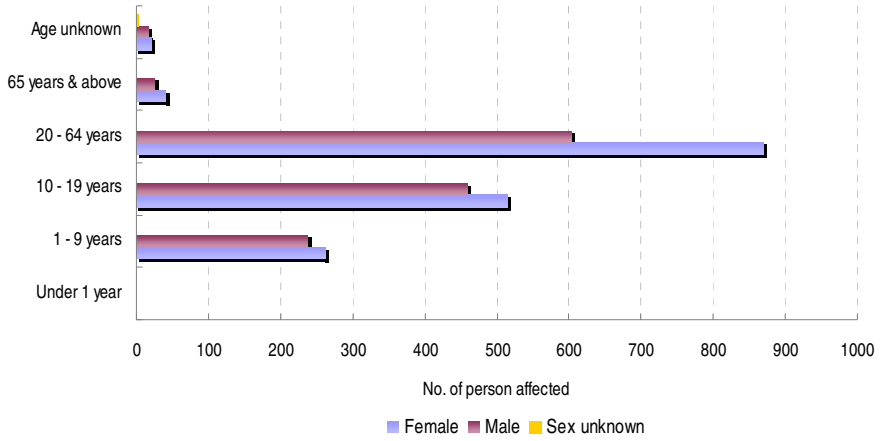



Figure 5. Size of food poisoning outbreaks attributed to *S. aureus*, 2001-2009



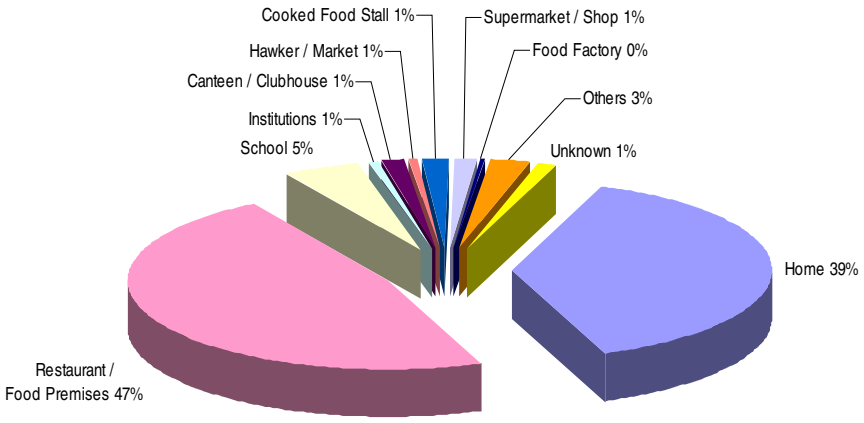

22. All age groups except those below 1 year were affected although persons aged 65 years or above were not commonly involved (Figure 6). There was no obvious sex preference (male to female ratio was 1:1.3). Only 66 affected persons (2.2%) required hospitalization and they recovered without complication.

Figure 6. Age and sex distribution of persons affected in staphylococcal food poisoning outbreaks, 2001-2009




23. Figure 7 shows nearly half of *S. aureus* related food poisoning outbreaks occurred at restaurant and food premises (47%), followed by homes (39%) and schools (5%). For the domestic cases, majority of outbreaks had the contaminated food purchased from cooked food stall, supermarket/shop and restaurant/food premises. For school outbreaks, lunch box (40%) was the main incriminated food vehicle and poor personal hygiene of food handlers was the main risk factor.

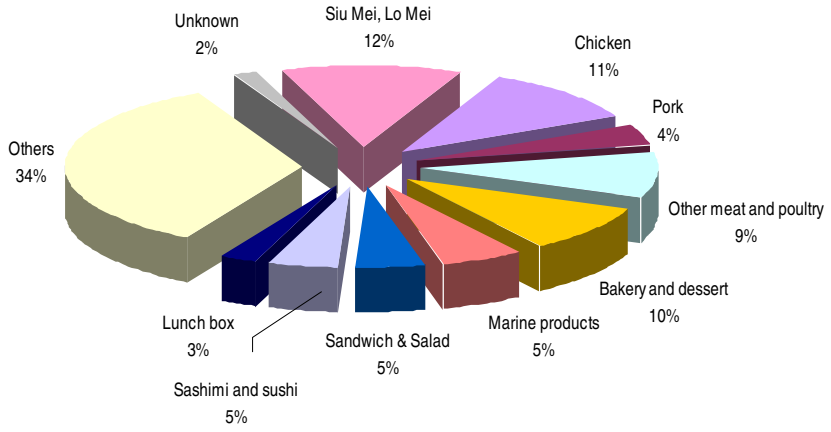
Figure 7. Place of consumption of staphylococcal food poisoning outbreaks, 2001-2009




24. Food vehicles associated with staphylococcal food poisoning outbreaks using all confirmed and suspected cases were shown in Figure 8. The most commonly associated food types were siu-mei, lo-mei and chicken. Other examples include poultry and other meat, bakery and dessert. Poor personal hygiene of the food handlers and improper storage of cooked food were identified as the contributing factors, especially in large outbreak involving

more than 20 persons. For sashimi and sushi, sandwich and salad, which require handling of ingredients by hand without further cooking, the main contributing factor was poor personal hygiene of food handlers. If only confirmed cases were analysed, the most commonly associated food types were still siu-mei, lo-mei and chicken while the main contributing factors were still poor personal hygiene of the food handlers and improper storage of cooked food.

Figure 8. Food vehicles associated with confirmed and suspected staphylococcal food poisoning outbreaks, 2001-2009




Large food poisoning outbreak confirmed to be related to S. *aureus*

25. Two local large-scale *S. aureus* related food poisoning outbreaks were reported in 2004 and 2006. The first outbreak was notified in May 2004 and affected 101 students and 1 staff member of a primary school in Tseung Kwan O. They presented with abdominal pain (88%), nausea (39%), vomiting (21%) and diarrhoea (16%) shortly (<1 hours to 3 hours) after taking lunch at the school. The lunch box of assorted sushi was implicated. *S. aureus* was isolated in food specimens and specimens from involved food handlers. Further investigation revealed undistinguishable PFGE pattern in a specimen of food handler (nasal swab) and 5 food specimens. Poor personal hygiene of the food handler was the main risk factor. In addition, the lunch boxes were also found to be transported from the food factory to the school at an inappropriate temperature. Health education has been provided to the involved food handlers.

26. The second outbreak, notified in September 2006, affected a total of 65 persons in 22 clusters (23). Patients presented symptoms of vomiting (95%), nausea (83%), abdominal pain (74%) and diarrhoea (74%). Incubation period ranged from 1.5 to 10 hours (median 3.5 hours). The incriminated food was take-away lo-mei and siu-mei. *S. aureus* was isolated from food specimens, environmental specimens and food handlers' nasal swabs with

highly similar PFGE pattern. Poor personal hygiene was found to be the main risk factor and inappropriate storage temperature of the incriminated food was noted in field investigation. A temporarily closure order was issued to the food premises.

Nasal carriage of *S. aureus* in food handlers

27. During investigation of notified food poisoning outbreaks, food handlers were interviewed for symptoms and their nasal specimens were collected. From 2001 to 2009, the estimated nasal carriage of *S. aureus* in food handlers involved in suspected staphylococcal food poisoning outbreaks was 17.7%. This figure is similar to the cross-sectional study conducted among food handlers with culture positive rate of 16.5% in Ethiopia (9). A local cross-sectional study recruited 736 dog owners from 7 veterinary practices in 2007, and reported the nasal carriage rate of 24% among them (24). Another local study published in 2005 indicated that *S. aureus* nasal colonization of 55 Chinese children with moderate to severe atopic dermatitis was 22% (25).

28. In summary, *S. aureus* is the third commonest bacterial food poisoning outbreak agent in Hong Kong. Most of the outbreaks affected less than 5 persons but occasionally large outbreaks occurred. The commonest associated food items were siu-mei, lo-mei, chicken and other ready-to-eat food purchased from food premises. Poor hygiene of the food handlers were often identified as the contributing factors in causing these outbreaks.

## Public Health Prevention and Control Measures

Screening of food handlers for *S. aureus*

29. There is no effective long term decolonization therapy for *S. aureus* carrier. Even with the use of antibiotics, *S. aureus* can only be removed from the nose over a few weeks, but relapses are common within several months (26). Although post treatment eradication may be initially high, sustained decolonization drops to half of cases 6 to 8 months after treatment (27). In fact, the World Health Organization published a report on health surveillance and management procedures for food handling personnel (28), indicating that pre-employment or routine medical and laboratory examinations of food handling personnel are of no value in the prevention of foodborne diseases. The report recommended those governments, industries and institutions that rely on medical examination of food handling personnel for the prevention of foodborne disease should discontinue the practice. In addition, it also stressed that importance of providing education and training in good hygienic practices to all food handling personnel.

30. In United States, Canada, United Kingdom, Australia and Singapore, there is no pre-employment and routine medical examination of food handlers (29-33). There is also no legal requirement to screen for *S. aureus* carrier state. Instead, food handlers are required to have the skills and knowledge in food safety and food hygiene by attending training course or through on-the-job training.

31. Similar to other areas, no pre-employment and routine medical examination for *S. aureus* for food handlers is required by the laws in Hong Kong. Nonetheless, the Food Business Regulation under Public Health and Municipal Services Ordinance (Cap 132X) requires food handlers to observe personal cleanliness and restricts sick food handlers from handling open food. For instance, person who is suffering from a discharging wound or sore on any exposed part of the body, or from a discharge of the ear or from attacks of diarrhoea or vomiting or from a sore throat is restricted from taking any part in the handling of open food. In view of a sizable proportion of the population are carrier of *S. aureus* and decolonization of *S. aureus* lacks proof of long term effectiveness, screening food handlers for *S. aureus* is not recommended.

Food poisoning investigation

32. Upon notification of food poisoning outbreaks, CHP will initiate prompt epidemiological investigation. Outbreaks associated with food premises would be referred to the Food and Environmental Hygiene Department (FEHD) for further investigation. CHP is responsible for active case finding, collecting clinical and epidemiological information from victims, analyzing the information, formulating an outbreak hypothesis, and passing the summary information to FEHD for its further investigation at relevant food premises. FEHD collects food and environmental specimens as well as clinical specimens from food handlers for laboratory investigation, provides specific advice on food hygiene, conducts source tracing and takes actions against any irregularities identified during the course of investigation at food premises. Health education on food hygiene and food safety will be stressed. Sale and distribution of incriminated food items may be suspended as appropriate. Closure order would be issued if food premises pose an immediate health hazard to the public.

Food surveillance and risk assessment studies

33. Food surveillance programme and risk assessment studies have been put in place by the Centre for Food Safety (CFS). Currently, food surveillance including routine, targeted and seasonal programmes are used (34). Health inspectors take samples at import, wholesale and retail levels for microbiological and chemical testing. Laboratory testing covers chemicals, viruses and bacteria including *S. aureus*. The results would be released regularly to promote public awareness.

34. CFS has also conducted risk assessment studies targeted on foods such as poached chicken, siu-mei and lo-mei which are high risk for *S. aureus* contamination. In assessing the microbiological quality of poached chicken for sale in retail outlets, a total of 247 poached chickens and 70 sauces were collected in 2007(35). *S. aureus* was isolated in 2 chicken samples. Another risk assessment study of siu-mei and lo-mei was published in 2001, which tested for 406 samples of siu-mei and 190 samples of lo-mei collected in 2000 (36). *S. aureus* was isolated in one siu-mei (BBQ pork) and one lo-mei (steamed plain chicken) samples. In both cases, post-cooking contamination and prolonged storage at inappropriate temperature might be the main contributing factors. FEHD has advised the trade and the public on safe preparation and handling of poached chicken based on the study result.

Education to trade and consumers

35. FEHD has prepared a variety of health education materials, e.g. pamphlet, posters, video, exhibition boards, etc. covering various topics of food poisoning and food safety for food handlers and the public. Strict food hygiene, sanitation, cleanliness in kitchen, proper temperature control, hand washing and personal hygiene are important measures in preventing staphylococcal food poisoning. Anyone who has skin infection should not prepare food for others until the infection heals. Food should be consumed immediately or refrigerated and not kept at room temperature to avoid proliferation of *S. aureus*. FEHD has published guidelines on how to select a proper lunch supplier and how to handle lunch boxes at the place of consumption (37). Guidelines to trade targeted for high risk food such as ready-to-eat food has been prepared (38). In addition, a trilingual telephone hotline on food safety and environmental hygiene has been operated by FEHD. In 2009, FEHD has published a Food Hygiene Code with general advice on food hygiene and food safety (39). It aimed to provide a set of model requirements to help food business achieve a higher degree of compliance with the food regulations and attain a higher standard of food hygiene and food safety through adoption of good practices.

## Recommendation

36. *S. aureus* is an important causative agent for food poisoning outbreaks worldwide. In Hong Kong, it is the third commonest food poisoning outbreak agent. Along with other pathogens causing food poisoning, the increasing trend of staphylococcal food poisoning has been reverted since 2007. This may be due to better food hygiene practices of the trade and consumers, as well as more targeted food surveillance programmes. Nevertheless, the followings are suggested to further prevent staphylococcal food poisoning in Hong Kong:

Outbreak involving lunch boxes may still occur when proper food safety practices are compromised. Schools and institutions should follow the guidelines published by FEHD to ensure proper handling of lunch boxes.

- Routine screening for food handlers for carrier of *S. aureus* is not recommended given the high prevalence of *S. aureus* in the population and that no effective long term decolonization therapy is available. Food handlers should be encouraged to join the education and training courses provided by FEHD to ensure good hygiene practices.

- To better document the disease burden of staphylococcal food poisoning, attending doctors should encourage patients to save their clinical specimens like stool or food remnant for isolation of the organism or detection of enterotoxin. Attending doctors should also report to Central Notification Office (CENO) of the CHP if they encounter any suspected staphylococcal food poisoning.

Centre for Health Protection
January 2011

## Appendix 1

### Laboratory criteria for confirmation of *S. aureus* food poisoning before 2007

Food poisoning organism or toxin detected from patient's clinical specimens or epidemiologically implicated food specimens (e.g. food remnant or sample from the same batch of food), provided that the patient's clinical picture is compatible with the presentation of the causative agent. This confirms the diagnosis of food-borne illness.

(A positive microbiological sample from a food handler in itself should not normally lead to classification of an outbreak as "confirmed", unless there is other strong supportive evidence to substantiate such classification)

### Laboratory criteria for confirmation of *S. aureus* food poisoning since 2007

1. Isolation of *S. aureus* from stool of two or more ill persons with same genetic pattern
2. Isolation of $10^4$ CFU *S. aureus*/g or above from remnant of the epidemiologically implicated food
3. Isolation of $10^4$ CFU *S. aureus*/g or above from sample of the same batch as the epidemiologically implicated food
4. Detection of staphylococcal enterotoxin in remnant of the epidemiologically implicated food irrespective of the number of *S. aureus* isolated
5. Detection of staphylococcal enterotoxin in sample of the same batch as the epidemiologically implicated food irrespective of the number of *S. aureus* isolated
6. Isolation of *S. aureus* with same genetic pattern from nasal swab or wound swab of one or more relevant food handlers i.e. those responsible for preparing the epidemiologically implicated food and from stool specimen of one or more ill persons

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