Bacteriological and serological survey of infectious diseases among food handlers in Makkah

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In the food industry, contamination from microorganisms can be responsible for infectious disease outbreaks passed from food employees to consumers through food. The origins of microbial contaminants in food surface facilities include the environment, food workers, the source of the food, and the food itself. According to a report by the Centers for Disease Control and Prevention (CDC), hands may be the most important means by which enteric pathogens are transmitted if employees do not wash their hands adequately.[1,2] Hands, arms and fingers of food handlers may become contaminated with fecal microorganisms after using the toilets. These organisms include *Staphylococcus aureus, Salmonella, Shigella* and hepatitis A virus. According to Buzby and Roberts these organisms account for approximately 3.3 to 12.3 million cases of illness and 39 000 deaths in the United State each year. They estimated that the annual cost of these foodborne illnesses, which includes costs to individuals, industry and the public health sector, is US $6.5 to $35 billion.[3]

Staphylococcal food poisoning resulting from the growth of enterotoxigenic staphylococci in foods with the production of enterotoxin is the most common food illness found in almost all parts of the world.[4] Enterotoxin produces symptoms similar to acute gastroenteritis. *Staphylococcus aureus* is widely distributed in nature and is commonly found in the nose, throat, hair, and skin of humans and animals. Foods such as bakery products, containing custards or cream, ham, poultry products, milk and milk products and eggs have been frequently reported as the source in outbreaks of staphylococcal food poisoning. Several staphylococcal enterotoxins have been identified and differentiated by serological techniques and have been given letter designations, SEA through SEF in which SEA is responsible for the majority of staphylococcal food illness.[5]

Salmonella is one of the most frequently isolated bacterial foodborne illnesses resulting from the ingestion of viable bacteria. Symptoms mainly consist of nausea, vomiting, abdominal pain, headache, chills and diarrhea. The primary habitat of *Salmonella* is the intestinal tract of humans and farm animals such as chicken, cattle and sheep.[4]

Hepatitis A virus (HAV) is another foodborne illness characterized by its ability to survive well on environmental surfaces and on human hands for up to 7 hours and be easily transferred to and from hands and surfaces. Additionally, this virus is resistant to many disinfectants used in food establishments. HAV is transmitted typically from person-to-person by the fecal-oral route. Foodborne transmission occurs when an HAV-infected food handler contaminates food during preparation, or when food is contaminated during harvesting or processing before reaching the food service establishment or home. Presentation of hepatitis A infection typically includes flu-like symptoms, which cannot be distinguished from other types of acute hepatitis.[6-10]

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Accepted for publication
June 2005

Ann Saudi Med 2006;26(2):141-144

Table 1. Prevalence of enterotoxic positive and negative *S. aureus* among tested samples.

	Nasal swabs	Throat swabs
Number of tested samples	259	259
Number positive for *S. aureus*	54 (20.8%)	4 (1.5%)
Number of enterotoxic positive isolates	11 (36%)	1 (25%)
Enterotoxin types and number of isolates	A (3), B (4) or C (4)	A and B (1)

This study was conducted to identify infected food handler workers in restaurants, cafeterias and catering companies who are infected with *Staphylococcus aureus, Salmonella* and HAV in Makkah city during the Hajj season 1424H (2004). In addition, this study tries to establish a strategy and recommendations to prevent the spread of these diseases as an outbreak in the future, particularly with the increasing numbers of pilgrims annually.

Subjects and Methods

Samples were collected from the five main private medical centers in Makkah involved in testing food handlers applying for health licenses between January to March 2004 (5th Thull Hejah to 22nd of Moharram, 1424/1425H). Four types of samples (nasal, throat, rectal swabs and blood) were collected from 259 food handlers. Nasal samples were taken by applying a sterile cotton-tipped swab 1 to 2 centimeters inside the anterior nares. Samples were tested on the same day received except blood samples which were separated (serum) and stored at -20°C, until the time of the assay.

For identification of *S. aureus*, all nasal and throat swabs were cultured on mannitol salt and blood agars and incubated for 24 hours at 37°C. The identity of *S. aureus* was confirmed by Gram stain, and catalase and coagulase tests. *S. aureus* enterotoxic strains were determined by the SET-RPLA staphylococcal enterotoxin test kit (Oxoid, UK). For *Salmonella*, all rectal swabs were collected in selenite broth and incubated at 37°C for 24 hours and then sub-cultured on xylose deoxycholate agar (XLD, (Oxoid, UK)) and incubated at 37°C for 24 hours. Identification of *Salmonella* was performed using a Gram stain and confirmed by latex agglutination and API 20E tests (BioMérieux, Inc.). For HAV, serum samples were examined using an enzyme immunoassay for the determination of IgM antibodies to HAV (DIA.PRO, Diagnostic, Milano-Italy).

Results

In nasal swabs, 54 (20.8%) of 259 tested samples were positive for *S. aureus*. Of the *S. aureus* positive samples; 11 (36%) produced staphylococcal enterotoxins. The serotypes of these enterotoxins were enterotoxin A (27%), enterotoxin B (36%) and enterotoxin C (36%). None of these isolates produced more than one type of enterotoxin (Table 1). In throat swabs, 4 (1.5%) samples were positive for *S. aureus*. Enterotoxigenic *S. aureus* was found in only one (25%) sample, which produced enterotoxins A and B (Table 1). Among the tested food handlers, only one case showed growth for *S. aureus* in both nasal and throat swabs and was negative for enterotoxin. *Salmonella* was detected in 2 of 259 tested food handlers for a prevalence of 0.8%. HAV was detected in 4 of 259 tested food handlers for a prevalence of 1.5%.

Discussion

Staphylococcus aureus inhabits human skin and mucous membranes in 25% to 30% of the population, where they exist mostly as a commensal flora. However, some *S. aureus* pathogenic strains are capable of causing different types of infections in both man and animals. *S. aureus* is an important cause of poisoning due to the production of serologically related heat-stable enterotoxins designated as staphylococcal enterotoxins A-E. Ingestion of these preformed toxins in contaminated food leads to symptoms of food poisoning.[11]

In the present study, nasal and throat swabs from food handlers in Makkah city were cultured for the presence of *S. aureus* and the isolates were examined for the production of staphylococcal enterotoxins. Fifty-eight (22.4%) food handlers were carriers for *S. aureus* (throat and nasal swabs). Enterotoxigenic *S. aureus* was found in 12 (20.6%) isolates and the most frequent enterotoxin was type B. These results are in agreement with Al-Bustan et al., who found a rate of 26.6% for *S. aureus* nasal carriage among 500 food handlers in the city of Kuwait.[12] However, Soto et al. demonstrated a much higher carrier percentage (65.5%).[13] These variations between regions clearly reflect differences in personal and environmental hygienic measures. The prevalence of *S. aureus* carriers was much higher in nasal swabs compared with throat swabs. This indicates that examining *S. aureus* from throat swabs only is not always a reliable way to detect the carriage of *S. aureus*.

Preparing food for the pilgrims during Hajj season is a highly vulnerable operation, and therefore

testing carriage among food handlers is of valuable assistance in planning preventive measures. Although in some countries individuals colonized with staphylococci are not allowed to handle food, this is not a practical solution to the problem, because it is difficult to control. The best recommended solution is the proper training of food handlers to prevent the contamination of vulnerable foods. Furthermore, foods should be kept either above 45°C or below 5°C during storage to prevent staphylococcal growth and enterotoxin production.[14-17]

Two rectal swabs (0.8%) were positive for *Salmonella* despite the fact that these subjects had a health license indicating routine surveillance of rectal swabs from food handlers on a regular schedule. This percentage is low in comparison to some studies performed in other countries, which ranged from 2.3% to 18%.[18-21] Although our percentage is low, it should not be ignored because of the high infectivity of this organism. This conclusion is supported by Khuri-Bulos et al., who demonstrated a *Salmonella* carriage rate of 18% among 61 food handlers who were negative 3 months before.[18] An intensive and continuous food hygiene education programs presented to all food handlers is an essential preventive measure.

The occurrence of HAV infection was low in this study (1.5%). Because of the high infectivity of this organism, one infected food handler can infect hundreds of people including other food handlers, particularly in crowded areas such as Makkah and Maddinah.[8,22] Additionally, the ability of the virus to survive in the environment for months may necessitates vaccination of food handlers against HAV virus to prevent possible outbreaks. However, to make vaccination cost effective, further studies are required to screen a large number of food handlers against HAV protective antibodies (IgG) before making the decision to vaccinate all workers since most food handlers in the Makkah region are from developing countries such as India and Pakistan, where most adults are immunized.[23,24] Furthermore, basic food hygiene should be considered such as heating food, washing hands and disinfecting surfaces with house bleach.[25]

We would like to thank Mr. Anas Dablul, Head of Public Health Laboratory, for his kind help in using the facilities of his laboratory and to Mr. Makki Deggna, Mr. Khalid Al-shareef and Mr. Omer Ben Jahlan, Public Health Laboratory, for their practical assistance. We would like to thank Dr. Yusif Khodary, the laboratory director of Al-Nour Specialist Hospital for his kind permission to use the serology department facilities. We thank all the private medical centers (Alfarraj, Altebby al-hadeeth, Asiya, Al-odwani and Al-saaedy) involved in this study for their kind help in samples collection. Finally, we thank Dr. Osamah Albar the Dean of the Custodian of The Two Holy Mosques Institute of Hajj Research for his cooperation to achieve this work.

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