INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 17, No. 3, p. 295-304, 2020

RESEARCH PAPER OPEN ACCESS

Safety assessment of food commodities through HACCP in Benazir Bhutto Shaheed Hospital, Pakistan

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Key words: Foodborne diseases, Hazard analysis and critical control point system, Hospital, Microbial contamination, Safety

http://dx.doi.org/10.12692/ijb/17.3.295-304 Article published on September 30, 2020

Abstract

In order to overcome the burden of foodborne issue throughout the world, there is an ongoing challenge of food safety that is required to be addressed on a global level. This present study deals with the food samples collected for microbial quality from Benazir Bhutto Shaheed Hospital, Pakistan. In this study, overall viable counts in foods along with the parameters being used to observe the absence or presence of fungi, bacteria, Staphylococcus, coliform, enteropathogenic Escherichia Coli and Salmonella were recorded. In order to test the water quality, list of coliform bacteria and aerobic mesophilic bacteria has been carried out. The results of this study deduced that the food consumed in the selected hospital was contaminated with microbes. Individual non-hygienic practices and serving areas were the major reasons for maximum contamination. The findings also reported fecal coliforms, salmonella and fungal cross-contamination. To monitor the high risk areas and major sources of contamination in the hospital an analysis and critical control point system was implemented. The present study concluded that Benazir Bhutto Shaheed Hospital, Pakistan had a very high prevalence rate of microbial contamination. To ensure the health and safety of patients, precautionary measures are required to be taken in the premises of this hospital.

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Introduction

Due to current relevance to public health, food safety has now become a main issue of public concern. Despite of recent advances in food science and technology, foodborne diseases still remain a major reason behind reduced economic productivity and one of the most widespread public health issues all over the world (King *et al.,* 2013). Because of availability of the contaminated food and water, there are still millions of individuals who are suffering from different communicable and non-communicable diseases. There are certain factors that contribute to foodborne diseases which include poor dry storage, inadequate thawing, contaminated water sources, ingredients raised from unsafe food, cross-contamination, insufficient refrigeration, food filling, unclean utensils and appliances, reheating and bare hand touch and preparing fried food items from already cooked foods. In developing countries, the changing socioeconomic situation caused certain challenges to food safety such as food accessibility, distribution and adequate maintenance (Christensen *et al.,* 2009). The major challenges being faced by many countries were supply of clean water as well as availability of healthy and nutritious food.

In fact, the reasons behind lower esthetic standards were lack of sanitation and physical facilities which further leads to contamination of food and water. In developing countries, the risk of foodborne disease was reported to be worse than that of developed countries and is more significant because of inadequate and poorly defined protection system and policies. In another study, it was proved that developing countries are suffering from issues such as large scale relocation to overcrowded areas, increasingly elevating demographics and extreme deprivation which further contributes to inadequate sanitation standards. It has also been reported that around 1.1 billion people do not have access to clean drinking water (Clayton and Griffith 2004). Hence it was concluded that because of lack of hygienic processing and storage facilities for produce, food health was substantial. Increased levels of microbial contamination in food items of hospital have been frequently reported. There were high counts of food-borne pathogens on eatables and foods supplied by hospital vendors. The foods sold on the street have often been recognized as a source of foodborne diseases although there is still not enough of epidemiological data available against these food items as the risk of foodborne diseases. Therefore, the objective of the present study was to attempt a comprehensive analysis of food protection, hygiene training and effects on hygiene practices at Benazir Bhutto Shaheed Hospital, Pakistan.

Material and methods

Study Design

Cross-sectional research study was undertaken during January to October 2008 to determine food safety through the use of hazard analysis and critical point techniques in teaching hospitals food catering establishments. Pretesting was done at Benazir Bhutto Shaheed Hospital. The country's public-sector teaching hospital, namely Benazir Bhutto Shaheed Hospital, Rawalpindi was included in the study. Data were obtained through a pretested questionnaire. The gathered information was focused on the following parameters: food intake, storage, heating, keeping and delivery of food, quality assurance, personal hygiene and sanitary activities.

Microbial analysis of foods

Parameters of microbiological consistency were used to assess the presence or absence of Salmonella, Staphylococcus, Coliforms, fungi, E.coli and overall other vital counts were studied. As mentioned by United Nations Food and Agriculture Organization (FAO), the consistency of water enumeration of aerobic mesophilic bacteria and coliform bacteria was tested.

Food and Water Sampling

Samples of cooked and uncooked food products were obtained from both food chains at essential control points like CCP1, CCP2 and CCP3, after cooking and retaining the product for a specific period. After cleaning and rinsing three times immersing in 95% alcohol, the metallic utensils set was used to collect samples. Samples were stored in sterile stomacher

bags with clipped fastener attached on. Hot food samples were cooled in water bowl and then promptly put in a sealed sample box containing 4°C coolants. Water samples were obtained from catering service water coolers that was used for dishwashing, cooking and drinking purpose. Samples were collected in sterilized glass stopper bottles and stored in coolants until they received by the microbiology labs, where they were subsequently tested (Clayton and Griffith 2004).

Laboratory procedures: culture media and diluents. Agar (PCA) for the account of mesophilic aerobic bacteria; Baird-Parker agar (BPA) for the enumeration of Staphylococcus sp. and Sabouraud dextrose agar (SDA) for the enumeration of fungal colonies; Bismuth sulfite agar (BSA) for Salmonella sp.; lauryl sulfate trytose (LST) broth for presumptive test of coliforms; bright green bile lactose broth for enumeration; Coli media to confirm fecal coliforms; Levine eosin methylene blue agar to confirm E.Coli; MacConkey Agar plates for enteropathogenic E. coli detection and LST for test of coliform bacteria. Peptone water was prepared with dehydrated peptone water and used as a diluent.

Preparation of Food homogenate

Under sterile conditions, food (10g) was mixed with 90mL of sterile peptone water in a laminar flow hood. After stirring in a stomacher blender for 1 to 3 min, the food particles were grinded. Homogenate was filtered by a clean filer. The homogenate (1mL) was mixed to form 102 dilutions in 9mL of autoclaved peptone water to form 10^{-2} dilutions. Similarly, serial dilution up to 10^{-5} was done for each food sample.

Inoculation and incubation

To enumerate the mesophilic aerobic bacteria, Staphylococcus sp.; Salmonella sp.; fungal spores and enteropathogens E and in the laminar flow hood coli, PCA, BPA, SDA, BSA and MacConkey agar plates were divided into five sections under sterile conditions, respectively. Each dilution was inoculated in duplicate of the food sample. Each section was labelled with correct number. Samples (0.1mL) was taken from first five dilutions of homogenate were pipetted and inoculated into marked plate and mixing the sample dilution with agar medium was performed in a detailed and uniformly and permitted to solidify. All plates were incubated in an upright position at a temperature and duration specified as follows: PCA at 308C for 48h; BPA at 378C for 48h; BSA at 378C for 24h; SDA at 20 to 258C for 72h; and MacConkey agar at 358C for 24h.

Calculations

The result was expressed as: 1×10^{0} bacteria per gram or milliliter, when the plates examined contained no colonies. When the colonies were more than 30 colonies were counted in both plates of a dilution and the average was measured, keeping just two meaningful digits and multiplying the inverse of the corresponding dilution to obtain the number of bacteria per gram or milliliter.

Enumeration of coliform bacteria

Coliform groups of bacteria included Klebsiella, Citrobacter, Enterobacter, and Escherichia.

Presumptive tests (most probable number)

(i) Each of three tubes of LST broth (containing inverted Durham tubes) was inoculated with 1.0mL of food homogenate (1 in 10).

(ii) The same operation was carried out from the first (1 in 100) and the second dilution (1 in 100). LST tubes were incubated at 37°C for 24h. After 24h, test of the gas output tubes were reported, and tubes with negative outcomes were re-incubated for a further 24 hours, during which the findings were reported.

(iii) For non-chlorinated water, five tubes of LST broth (10-mL quantities of double strength) were inoculated with 10mL of water samples, and five tubes of the media (single strength) of 5-mL quantities were inoculated each with 1mL of water, and another set of five tubes of 5-mL quantities were inoculated each with 0.1mL of water. These tubes were incubated at 35°C for 48h.

Confirmation test for coliforms for E. coli

A loopful was transferred from each gas-positive LST broth tube to spate brilliant green bile lactose broth tubes, which were incubated at 37°C for 48h. Gas formation indicated by broth color change confirmed

the presence of coliforms. The amounts of positive tubes were observed.

Confirmation test for fecal coliform

A loopful transmitted from each gas-positive LST tube into a separate E tube. Coli medium broth, incubated at 44.5°C for 48h. The number of positive tubes were observed.

Confirmation test for E. coli

Loopful of suspension from each gassing the E.coli medium tube was lined on Levine eosin methylene blue agar, plates were incubated at 38°C for 24h. After incubation, the plates were examined for E. coli colonies. One or two of colonies from each Levine eosin methylene blue agar plate were shifted to PCA slants for biochemical and morphological test. Slants were incubated for 24h at 37°C.

Calculations for coliforms

The quantity of positive tubes were noted for E. coli media broth, LST broth, brilliant green bile lactose broth. The most likely number was recorded for positive tubes according to the most likely number index (Collins and Taylor 1969). Total microbial counts were calculated except entropathogenicc E.coli, it was enumerated separately.

Microbial evaluation of environmental samples

Microbial surface evaluations were carried out using the "Scotch tape" method as mentioned (Davey 1985). Sample of food cans and cookware were collected prior to food preparation using a rinse method. The fingertips of food servers and food production personnel were immersed in small sterile plastic bags containing 75ml of sterile peptone water. Serial dilution of this rinse liquid up to dilution factor of 10^{-5} was achieved. Duplicate spread plates were prepared from each of the dilutions using SDA and PCA. Plates were incubated at 30°C to 35°C for 48 hours.

Morphological Studies

The isolation and characterization of the fungal colonies was carried out in accordance with the method described (Estremera-Cea 2007). Gram staining of bacterial isolates was performed, slides were observed, and organisms were classified as gram-positive or gram-negative.

Biochemical confirmatory test for bacterial isolates from food or water

The biochemical confirmatory test for the bacterial isolation from food and water samples was conducted: viable plate count, fecal coliform, bacilli or cocci, coliform count, growth on BPA for Staphylococcus aureus and fungus growth on BSA for Salmonella species (Noreen *et al*., 2012). Biochemical tests for Klebsiella species, Staphylococcus species, Acinetobacter sp., Enterobacter, Pseudomonas species, E.coli, fungal Proteus mirabillis, Bacillus sp., Proteus sp., Diplococcus sp., Citrobacter freundii and gram-positive Bacillus were also included.

Data management and presentation

Result of microbial growth in food and water, on fingertip, utensil were tabulated for the hospital. Findings of the samples examined by the division of public health laboratories in a satisfactory condition. The proportion of contaminated samples were presented in bar diagrams. The finding of the KAP portion of the analysis were tabulated.

Results

Microbiological Analysis for Benazir Bhutto Shaheed Hospital, Pakistan

Microbiological analysis

Microbial contamination of food samples from kitchen, canteen, vendors and patient's home at Benazir Bhutto Shaheed Hospital, Rawalpindi has shown in Fig.: 1. Results of the lab analysis for microbial loads of food samples belonging to the kitchen of Benazir Bhutto Shaheed Hospital, Rawalpindi are given in Table 1. out of the total 29 food samples 11 (37.9%) were found positive for fecal coliforms; 16 (55.2%) had viable plate counts with the lowest counts among the contaminated samples for raw tomatoes $2.6x10^4$ and the highest $6.0x10^5$ for raw dal mung. Coloforms were noted in 14 (48.3%) samples. Among the samples showing coliform presence the values ranged from $2.0x10^3$ raw (mixed vegetables) to $1.0x10^6$ (raw dal mung). Nine samples were fount contaminated with salmonella making 31% to the total with an average value of $2.64x10^4$

counts per g and ranging from $6x10^3$ for raw tomatoes to $2x10^5$ counts/g in the case of raw mixed vegetables. Staphylococcus and fungal contaminations were noted in 31 and 34.5% samples, respectively. On the basis of public health laboratories testing 17 (58.6%) samples were found unsatisfactory for consumption. The very high number of contaminated samples as well as the level of contamination indicates negligence towards food safety practices as well as unsafe sources of food and water at the hospital. This is also supported by the presence of fecal coliforms in one of the tap water samples and two unsatistactory water samples out of 5. Three of the four food processing/catering personnel (Table 4) had their fingertips positive for fecal coliforms, coliform plate counts and staphylococous contamination and all of them were positive for carrying bacterial load; all these resulting in the final finding that their situation was hygienically unsatisfactory for work in a food supply unit in a hospital. Eleven food samples were collected from food vendors around the hospital and subjected to microbiological evaluation (Table 2). Results showed that 18% of the food samples were positive for fecal coliforms, 5 samples had viable plate counts ranging from $4x10^3$ (cooked sponge gourd) to $3.5x10^6$ in raita (spiced yogurt with cut vegetables) with an average value of $8.25x10^5$. Coloforms were noted in 2 (18.2%) samples i.e. rice chole+salad ($3x10^5$ cfu/g) and Raita ($2x10^4$ cfu/g). The same two among all the samples were also positive for fungal contamination. Rice chole+salad was also positive for salmonella ($6x10^4$ cfu/g), while 4 (36.4%) samples were contaminated with staphylococcus species. Among the staphylococcus contaminated samples the minimum was found in ojri ($4x10^4$ cfu/g) and maximum in Rice chole + salad ($4x106^6$ cfu/g). In total 5 (45.5%) of the vendor food samples were found unsatisfactory with respect to their microbiological quality. In order to test the samples for vibrios contamination the selective medium of thiosulphate-citrate-bile salts-sucrose (TCBS) was used. Results showed that none of the samples had any vibrios contamination. The number of food samples taken for microbial examination from canteen of the Benazir Bhutto Shaheed Hospital, Rawalpindi was 35 (Table 3). Results indicated that 6 (17.1%) of all the samples had fecal coliform contamination, 14 (40%) gave viable plate counts with mixed masala (spices) carrying the highest load; 6 samples had coliform contamination with minimum value ($1.6x10^5$ cfu/g) noted for Channa chat and maximum ($3x10^6$) for raw beef; 4 (11.4%) samples had salmonella contamination ranging from $1x10^5$ to $2x10^6$ cfu/g while 10 samples (28.6%) had staphylococcus and 4 of the samples had fungal contaminations. On overall basis a total of 14 samples (40%) were rated as unsatisfactory. The two food catering/cooking personnel and two utensil samples were all positive for viable plate counts and their hygienic condition was found unsatisfactory. Both the personnel had coliform and one of them staphylococcus contamination. None of the food samples from canteen, finger tips of the food personnel or utensils had any vibrios contamination. Among the food samples from patients' home 1 was found positive for fecal coliforms, 5 gave viable plate counts, 3 carried coliforms, 1 had salmonella, 2 had stphulococcus and 1 had fungal contaminations resulting in a total of 60% of the samples being rated as unsatisfactory microbiologically. Five tap water samples were evaluated for their microbial quality (Table 5). It was noted that one of them was carrying fecal coliforms and two gave viable plate counts.

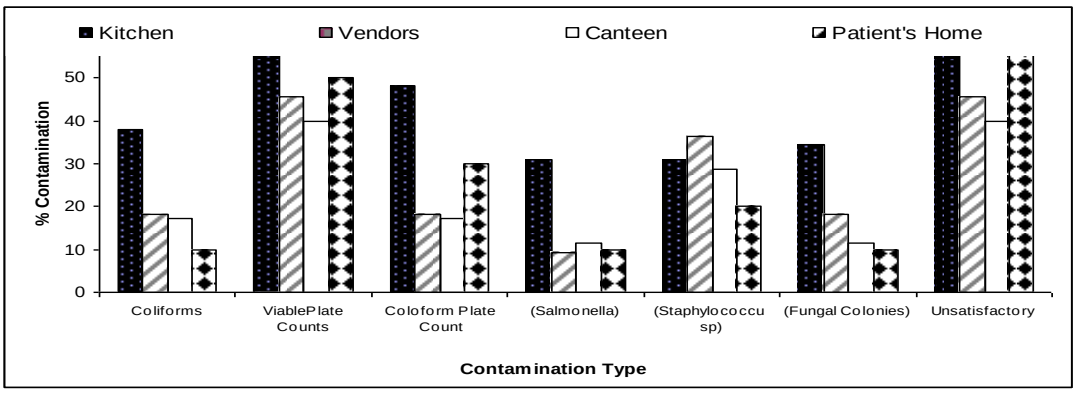

Fig. 1. Microbial contamination of food samples from kitchen, canteen, vendors and patient's home at Benazir Bhutto Shaheed Hospital, Rawalpindi.

Table 1. Microbial counts of foods samples belonging to the kitchen of Benazir Bhutto Shaheed Hospital, Rawalpindi.

Description of Sample	Fecal Coliforms	Viable Plate Counts	Coliform Plate Count	BSA (Salmonella)	BPA (Staphylo coccus sp)	SDA (Fungal Colonies)	Status/Remarks
Double Roti (Bun)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Tea (ready)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Boiled Egg	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Dal Channa	+	1.0E+05	2.0E+04	8.0E+03	2.8E+04	+	Unsatisfactory
Wheat dough	+	1.4E+05	1.0E+05	5.0E+04	3.6E+04	+	Unsatisfactory
Mixed Masala (all spices)	+	2.3E+05	2.0E+05	0.0E+00	1.0E+04	+	Unsatisfactory
Omelet	-	2.0E+05	0.0E+00	0.0E+00	0.0E+00	+	Unsatisfactory
Omelet (raw material)	+	1.6E+05	7.4E+04	2.8E+04	8.0E+03	-	Unsatisfactory
Haleeb Milk	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Garlic + Ginger (raw)	+	2.0E+05	3.1E+05	1.4E+05	0.0E+00	-	Unsatisfactory
Raw Peas+ Carrot	+	2.0E+05	3.1E+05	1.4E+05	0.0E+00	-	Unsatisfactory
Raw Tomatoes	-	2.6E+04	1.0E+04	6.0E+03	0.0E+00	+	Unsatisfactory
Mixed Masala (all spices)	+	2.1E+05	4.4E+04	0.0E+00	0.0E+00	+	Unsatisfactory
Raw Rice	-	4.0E+05	0.0E+00	0.0E+00	0.0E+00	+	Unsatisfactory
Raw Tomato + Chilies	+	4.0E+05	2.3E+05	3.4E+04	6.0E+03	+	Unsatisfactory
Alu+BandGobi+Gajr+Salad(Raw)	+	4.2E+05	2.7E+05	2.0E+05	2.7E+05	+	Unsatisfactory
Dal Mung (raw)	-	6.0E+05	1.0E+06	0.0E+00	0.0E+00	-	Unsatisfactory
Chicken (raw)	+	4.0E+05	5.0E+05	1.6E+05	2.0E+05	-	Unsatisfactory
Brost Spices	-	2.4E+05	1.4E+04	0.0E+00	8.0E+03	+	Unsatisfactory
Kichri	-	2.0E+05	2.0E+03	0.0E+00	1.0E+04	-	Unsatisfactory
Rice + Mix Vegetables (ready)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Raita (ready)	+	3.0E+04	0.0E+00	0.0E+00	0.0E+00	-	Unsatisfactory
Rice + Mix Vegetable(ready)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Dal Masoor	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Chicken Roast	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Dal Mash + Mung (ready)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Alu Gajr Salan (cooked)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Alu Gobi Salan	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Alu+Gobi+Gajr+Mattar Salan	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Positive Samples and their%age	11 (37.9%)	16 (55.2%)	14 (48.3%)	9 (31.0%)	9 (31.0%)	10 (34.5%)	17 Unsatisfactory (58.6%)
Average		1.43E+05	1.06E+05	2.64E+04	1.99E+04		
Minimum		0.00E+00	0.00E+00	0.00E+00	0.00E+00		
Maximum		6.00E+05	1.00E+06	2.00E+05	2.70E+05		

Table 2. Microbial loads at the fingertips of food personnel at Benazir Bhutto Shaheed Hospital, Rawalpindi.

Description of Sample	Fecal Coliforms	Viable Plate Counts	Coliform Plate Count	BSA (Salmonella)	BPA (Staphylo coccu sp)	SDA (Fungal Colonies)	Status/ Remarks
Finger tips	+	90 Colonies	5 Colonies	0.0E+00	10 Colonies	-	Unsatisfactory
Finger tips	+	150 Colonies	30 Colonies	0.0E+00	30 Colonies	-	Unsatisfactory
Finger tips	+	120 colonies	0.0E+00	0.0E+00	40 colonies	-	Unsatisfactory
Finger tips	-	100 colonies	50 colonies	0.0E+00	0.0E+00	-	Unsatisfactory

Table 3. Microbial counts of foods samples belonging to Canteen of Benazir Bhutto Shaheed Hospital, Rawalpindi.

Description of Sample	Fecal Coliforms	Viable Plate Counts	Coliform Plate Count	Salmonella	Staphylo Coccu sp	Fungal Colonies	TCBS	Status/ Remarks
Raw Milk	+	6.0E+05	1.2E+06	0.0E+00	6.0E+05	-	0	Unsatisfactory
Boiled milk	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Tea (ready)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Mixed Masala (spices)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Peeled Tomatoes	-	1.0E+05	1.8E+05	0.0E+00	6.0E+05	-	0	Unsatisfactory
Slices	+	4.0E+05	0.0E+00	0.0E+00	0.0E+00	-	0	Unsatisfactory
Half Fried Egg	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Cake Piece	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Boiled milk	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Mixed Masala (spices)	+	5.0E+06	1.2E+06	1.0E+05	1.0E+05	+	0	Unsatisfactory
Tea	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Raw Beef	+	4.0E+06	3.0E+06	1.0E+06	6.0E+04	+	0	Unsatisfactory
Sugar	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Samosa	-	4.0E+05	0.0E+00	0.0E+00	1.2E+05	-	0	Unsatisfactory
Pakora Masala	-	2.6E+05	0.0E+00	0.0E+00	1.4E+05	-	0	Unsatisfactory

Description of Sample	Fecal Coliforms	Viable Plate Counts	Coliform Plate Count	Salmonella	Staphylo Coccu sp	Fungal Colonies	TCBS	Status/ Remarks
Boiled Egg with Base	-	4.0E+06	1.0E+06	1.0E+06	3.0E+06	+	0	Unsatisfactory
Shami Kabab	+	1.0E+05	0.0E+00	0.0E+00	6.0E+05	+	0	Unsatisfactory
Chatni	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Tea	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Rice (cooked)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Alu Qeema	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Fried Beef	-	2.4E+05	0.0E+00	0.0E+00	0.0E+00	-	0	Unsatisfactory
Vegetable(ready)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Rice(cooked)	-	4.0E+04	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Dal Channa (cooked)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Channa (ready)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Chicken	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Pakora (cooked)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Channa (ready)	-	2.4E+05	0.0E+00	0.0E+00	0.0E+00	-	0	Unsatisfactory
Vegetable (mixed)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Qeema Mattar	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Fried Beef	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	0	Satisfactory
Dal Channa (cooked)	-	0.0E+00	0.0E+00	0.0E+00	2.0E+04	-	0	Unsatisfactory
Channa Chat	+	1.4E+05	1.6E+05	2.0E+06	3.2E+06	-	0	Unsatisfactory
Dahi Bhalay	-	4.0E+06	0.0E+00	0.0E+00	0.0E+00	-	0	Unsatisfactory
Positive Samples and % age	6 (17.1%)	14 (40%)	6 (17.1%)	4 (11.4%)	10 (28.6%)	4 (11.4%)	0	14 (40%)
Average		5.58E+05	1.93E+05	1.17E+05	2.41E+05			
Minimum		0.00E+00	0.00E+00	0.00E+00	0.00E+00			
Maximum		5.00E+06	3.00E+06	2.00E+06	3.20E+06			

Table 4. Microbial counts of water samples at Benazir Bhutto Shaheed Hospital, Rawalpindi.

Description of Sample	Fecal Coliforms	Viable Plate Counts	Status/Remarks
Tap Water	-	0.0E+00	Satisfactory
Tap Water	+	1.0E+03	Unsatisfactory
Tap Water	-	1.2E+02	Unsatisfactory
Tap Water	-	0.0E+00	Satisfactory
Tap Water	-	0.0E+00	Satisfactory

Table 5. Microbial counts of foods from patient's home at Benazir Bhutto Shaheed Hospital, Rawalpindi.

Description of Sample	Fecal Coliforms	Viable Plate Counts	Coliform Plate Count	BSA (Salmonella)	BPA (Staphylo coccu sp)	SDA (Fungal Colonies)	Status/ Remarks
Noodles	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Dalia	-	4.0E+04	0.0E+00	0.0E+00	8.0E+04	-	Unsatisfactory
Saag	-	1.0E+03	0.0E+00	0.0E+00	0.0E+00	-	Unsatisfactory
Dalia	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Choty Gosht ka Salan	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Meat Salan	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Unsatisfactory
Mattar Gosht	-	8.0E+04	2.0E+05	0.0E+00	0.0E+00	-	Unsatisfactory
Chicken Salan	+	3.0E+06	2.4E+06	1.4E+05	4.0E+05	+	Unsatisfactory
Alu Palak (cooked)	-	0.0E+00	0.0E+00	0.0E+00	0.0E+00	-	Satisfactory
Channa Dal (cooked)	-	6.0E+04	2.0E+04	0.0E+00	0.0E+00	-	Unsatisfactory
Positive Samples and their%age	1 (10%)	5 (50%)	3 (30%)	1 (10%)	2 (20%)	1 (10%)	6 (60%)
Average		3.18E+05	2.62E+05	1.40E+04	4.80E+04		
Minimum		3.00E+06	2.40E+06	1.40E+05	4.00E+05		
Maximum		0.00E+00	0.00E+00	0.00E+00	0.00E+00		

Discussion

Microbiological analysis

Microbiological study of food products from hospital canteen and stall, food from patients' houses, fingertips of medical workers, utensils and water from various water cooler at Benazir Bhutto Shaheed Hospital. The value recorded for Benazir Bhutto Shaheed Hospital was 58.6%. High rate of microbial contamination are commonly recorded in patient meals and are easily minimized with the help of

HACCP system. Food safety in health care is a daily challenge, as there are many potential risks to hospital food at any point during the journey to the patient's trays. Large volumes of food are prepared, brought in by contractors, distributed though long corridors, kept warm at safe temperatures, served my many number of patients by many hands. Food hygiene and food safety in hospitals and aged care facilities can be ensured by adequate risk management includes staff training, regular food safety, assistance of products and services to observe food safety standards and procedures (Green 2005). Food safety practices in handling the food in many hospitals are not regularly observed, leading to higher microbial contamination during administration than preparation, even in hospitals in which people are trained about the concept and practices of HACCP (International Organization for Standardization 1988), hence, necessitating a regular system of training and surveillance for ensuring maximum food safety and compliance to good manufacturing practices. High contamination of food supplied by the vendors around the hospital is understandable, as street vended foods have shown links with illnesses (Jaafar *et al.*, 2014), and laboratory results have shown high counts and presence of foodborne pathogens on these foods (Christensen *et al.*, 2009).

Most of the food handling personnel in almost all hospital in the present study had contaminated fingertips. Touching cooked foods by these personnel can lead to outbreaks of staphylococcal food poisoning, shigellosis, septic sore throat, hepatitis A, and Norwalk gastroenteritis (Collins and Taylor 1969). The infected food handler can be responsible for the transmission of infectious intestinal diseases caused by foodborne pathogens. It is believed that personal hygiene practices with varying levels of complexity can help prevent foodborne pathogens from entering the food chain (Noreen *et al.*, 2012).

Biochemical confirmation of microorganisms

Selected food and water samples were analyzed by public health laboratories for identification of the contaminating organisms. Of the total contaminated samples, 9 (31.0%) were contaminated with Salmonella species, 9 (31.0%) with Staphylococcus species, and 14 (48.3%) with E. coli and 10 (34.5%) contaminated with fungal colonies. Acinetobacter is main cause of infection in debilitated patients in the hospital. They are generally considered nonpathogenic to healthy individuals. However, several species persist in hospital environments and cause severe, life-threatening infections in compromised patients. Among the Bacillus species, two medically significant are Bacillus anthracis, which causes anthrax, and Bacillus cereus, which causes a foodborne illness similar to that of Staphylococcus (Jarvis 1996). Citrobacter is gram-negative coliform bacteria, found almost everywhere in soil, water, wastewater, and in the human intestine. It is rarely the source of illnesses, except for infections of the urinary tract and infant meningitis and sepsis (Karch 2005). Gram-negative diplococci cause chlamydia and gonorrhea, and gram-positive cause pneumonia.

Virulent strains of E. coli can mainly cause gastroenteritis, urinary tract infections, and neonatal meningitis (Lammerding and Fazil 2000). E. coli causes foodborne illness, and infection often leads to bloody diarrhea, and occasionally to kidney failure, especially in young children and elderly people. Most illness has been associated with eating undercooked, contaminated ground beef, drinking unpasteurized milk, swimming in or drinking contaminated water, and eating contaminated vegetables (Liaw *et al.,* 2000). Enterobacter is a genus of the family Enterobacteriaceae. Some strains are pathogenic and cause opportunistic infections in immunocompromised (usually hospitalized) hosts. Pseudomonas spp. is a clinically significant and opportunistic pathogen, often causing nosocomial infections, in addition to causing serious and often lifethreatening diseases and exhibiting innate resistance to antibiotics. Staphylococcus can cause a wide variety of diseases in humans and other animals through either toxin production or invasion. Staphylococcal toxins are a common cause of food poisoning, as they can grow in improperly stored food (Noreen *et al.*, 2012).

Food handling process and temperature monitoring

Three critical control points were identified in the preparation of foods: at the stages of preparation (CCP1); cooking (CCP2); and hot holding (CCP3). The critical limits for CCP1 was not more than 2h at room temperature for perishable ingredients; for CCP2, it was at or above 75°C in all parts of food during cooking; and for CCP3, it was at or above 60°C in all parts of food until served. Food items not meeting the critical limits at any of the CCPs during temperature monitoring were rated as nonsatisfactory. It has been previously reported that hazards in our setups are primarily associated with holding of foods after preparation, and the critical control points in food preparation are cooking, manipulation of foods after cooking, holding cook foods, and reheating (Green 2005). Food during holding may remain within a temperature range that would promote rapid multiplication of bacteria. Even in developed countries, 20 to 40% of the reported outbreaks of foodborne diseases have been traced to mishandling of food. Cooking processing may eliminate the aerobic colony counts, but spores may survive and germinate during improper temperature holding.

High temperature holding maintains safe foods and hence is a critical control point. Education of the food handling personnel on these matters can be instrumental in maintaining food safety standards at hospital kitchens and canteens (Michaels *et al.,* 2004). Holding foods after cooking is a critical control point. Quite a number of studies have been reported on HACCP analysis of food preparation and provision facilities in various setups in the country (Ryan and Ray 2004). However, a study on food safety management in the food provision chain of various hospitals around the country is not available. Results of the present multicenter study will help health authorities and policy makers plan for the food safety and risk management in hospitals on the basis of objective evidence. Many studies have been reported on the application of HACCP principles in the preparation and distribution of food in hospitals around the world (Mortimore and Wallace 2013). As it is for all other large food catering systems, health care facilities around the world are faced with the daily challenge of food safety. Large volumes of food are prepared on a daily basis, undergoing a long series of operations related to preparation, maintenance at warm temperatures, and distribution to a large number of patients, which makes the food vulnerable to many food safety lapses. Food safety and hygiene can be ensured by adequate risk management that incorporates training and regular food safety auditing for adherence of the food service staff to food safety standards. Food safety training becomes an even more important and integral part of risk management in hospitals in which a large number of food processing and distribution staff is involved. Epidemiological studies and hazard analysis are the tools to identify hazards and practical preventive measures under a given set of processing practices. Information thus generated should be brought to the knowledge of public health authorities to focus attention on set priorities to take preventive measures. Present data amply demonstrate the value of conducting HACCP evaluation to detect foodborne disease hazards and to focus attention on their control (Wagenlehner *et al.*, 2015).

This procedure is particularly applicable to the present situation in Pakistan, where foodborne disease surveillance activities are very scarce.

Conclusion

The study concluded that various precautionary measures had to be taken to ensure the safe food handling in the public sector hospital Benazir Bhutto Shaheed Hospital, Rawalpindi. The food safety certifications and systems, such as HACCP, need to be strictly implemented in the hospitals and facilities where food handling is to be done. Moreover, the safety can also be maintained and ensured by the awareness of the food personnel of hospital toward food safety.

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