Safety of patient meals in 2 hospitals in Alexandria, Egypt before and after training of food handlers

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سلامة وجبات المرضى في مستشفيَيْن بالإسكندرية، في مصر، قبل وبعد تدريب المشرفين على الطعام فيهما

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الخلاصـة: درس الباحثون ما لدى 23 من المشرفين على الطعام في مستشفيَيْن في الإسكندرية، بمصر (مستشفى جمال عبد الناصر ومستشفى معهد البحوث الطبية) من معلومات حول سلامة الغذاء وما يتبعونه من ممارسات لتقديم الطعام، وذلك قبل وبعد إخضاعهم لبرنامج تدريبي حول سلامة الغذاء، وحول معدَّات المطبخ، وجودة وجبات المرضى. وقد لوحظ تحسُّن ملحوظ في جميع المُتَشابتات المرتبطة بالمعارف باستثناء النظافة الشخصية في مستشفى جمال عبد الناصر. كما لوحظ تحسُّن في ممارسات سلامة الغذاء في كلا المستشفيَيْن مع تحسُّن في الجودة البكتريولوجية لدى معظم وجبات المرضى وسطوح تحضير الغذاء وأوانيه بعد التدريب، وكانت الجودة البكتريولوجية للوجبات المقدَّمة في مستشفى جمال عبد الناصر أفضل بشكل عام مما كانت عليه في مستشفى معهد البحوث الطبية.

ABSTRACT We assessed the food safety knowledge and food handling practices of 23 food handlers in 2 hospitals in Alexandria, Egypt [Gamal Abdel Nasser (GAN) and Medical Research Institute (MRI)] before and after a food safety training programme, and also the bacteriological quality of patient meals and kitchen equipment. There was a significant improvement in all knowledge-associated parameters except for personal hygiene in GAN. There was an improvement in the food safety practices in both hospitals. The bacteriological quality of most patient meals and food preparation surfaces and utensils improved after training. The bacteriological quality of patients' meals served in GAN was generally better than that in MRI.

Sécurité sanitaire des repas servis aux patients dans deux hôpitaux d'Alexandrie (Égypte) avant et après la formation des personnes manipulant les aliments

RÉSUMÉ Nous avons évalué les connaissances en sécurité sanitaire des aliments et les pratiques de 23 personnes qui manipulent les aliments dans 2 hôpitaux d'Alexandrie (Égypte) [Gamal Abdel Nasser (GAN) et Institut de recherche médicale (IRM)] avant et après un programme de formation sur la sécurité sanitaire des aliments, ainsi que la qualité bactériologique des repas servis aux malades et des équipements de cuisine. On a observé une amélioration significative de tous les paramètres associés aux connaissances, à l'exception de l'hygiène personnelle à l'hôpital GAN, et une amélioration des pratiques en matière de sécurité sanitaire des aliments dans les deux hôpitaux. La qualité bactériologique de la plupart des repas servis aux patients et des surfaces et ustensiles servant à la préparation des aliments s'est améliorée à la suite de la formation. D'une façon générale, celle des repas servis aux patients de l'hôpital GAN était meilleure qu'à l'IRM.

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Introduction

The importance of safe food for hospitalized patients and the detrimental effect that contaminated food could have on their recovery has been emphasized [*1*]. Patients receiving foods from a single kitchen with poor food handling practices could suffer a foodborne infection which could result in an outbreak involving the whole hospital [*2*].Outbreaks of foodborne infection in hospitals are associated with high attack rates and disruption of services [*3*]. In 2002, hospitals in The Netherlands were implicated in 9% of 281 gastroenteritis outbreaks [*4*]. In Poland, the annual outbreaks of food poisoning and foodborne infections in hospitals and sanatoria from 1985 to 1999 constituted from 1.5% to 6.3% of the total number of such outbreaks in the country [*5*]. A foodborne outbreak of salmonella infection at a private hospital in London in 1994 had an attack rate estimated to be 5% among the approximately 200 patients and staff at risk [*3*].

Outbreaks of foodborne infections in hospitals are preventable but are facilitated by several factors; these include staff carriers, poor hygiene conditions in the kitchens, carelessness, and lack of training of food handlers. The particular danger of contaminated food in hospitals is that such food is given to consumers in poor health [*6*]. In Bavaria, a *Salmonella enteritidis* outbreak in hospitals and nursing homes resulted in 6 deaths [*7*], and in Australia [*8*], outbreaks in hospitals and facilities caring for the aged were responsible for 35% of deaths from foodborne infections. Hence there is a great need for education and increased awareness among food services staff in hospitals regarding safe food handling practices [*9*].

The aims of this study were to assess the bacteriological quality of patients' meals and the kitchen utensils in 2 hospitals in Alexandria and the food safety knowledge and food handling practices of the food handlers before and after a training programme of food safety.

Methods

This study was carried out in the kitchens of the Medical Research Institute (MRI) hospital and Gamal Abdel Nasser (GAN) hospital in Alexandria, which are health insurance hospitals. The study began in March 2003 and lasted about 15 months. It was preceded by a 3-month pilot study to check the effectiveness of the predesigned food safety knowledge questionnaire and food handling checklist in covering the required data. The study was carried out in 3 stages separated by 2–4-month intervals.

- Pre-training stage (7 months) (4 months in MRI and 3 months in GAN)
- Training stage (2 months) (1 month in each hospital)
- Post-training stage (6 months) (4 months in MRI and 2 months in GAN).

Pre-training stage

The food safety knowledge and food handling practices of all 23 food handlers (14 in MRI and 9 in GAN) were assessed. The handlers were interviewed using a predesigned questionnaire to assess their knowledge while an observational sanitation checklist was completed to assess food handling practices. The following parameters, with their associated items, were included.

- Building and facilities (location of the kitchen and its surroundings, its design and construction, cleaning and waste disposal, pest control and toilet facilities)
- Equipment and utensils (materials and

condition of food equipment and utensils and methods of cleaning).

- Personal hygiene (presence of health certificates and their validity, health status of food handlers, hand-washing and drying practices, avoidance of bad habits).
- Food handling (receipt of food, its storage, preparation, cooking and serving)

Each item was composed of several questions, each question was given a score of 1 if the answer (knowledge/practice) was correct or zero if incorrect. The knowledge/practice score of each parameter was calculated by summing the question scores and converting into percentages. The score percentage of each parameter of each food handler was used to calculate the mean percentage of each hospital.

During this stage, samples of patients' meals during their serving and swabs from food contact surfaces were collected and examined for the bacteriological quality.

Training stage

Training needs were identified based on inadequacies in food safety knowledge and practices of the food handlers that were noted during the pre-training stage. The observed misconceptions that most or some of the handlers had included the following:

- It is preferable to use pieces of cloth to dry cleaned hands rather than paper towels or a mechanical hand drier.
- It is not necessary to dry cleaned equipment and utensils before storage.
- Health certificates are substitutes for observing personal hygiene.
- It is preferable to use unheated tap water and soap rather than using warm water and soap for cleaning hands.
- Raw foods of animal origin are rarely contaminated with microorganisms.
- Food products that look uncontaminated cannot cause food poisoning.
- There is no problem of repeated thawing and refreezing of frozen foods.
- Cooking foods will destroy all microbial forms.
- Cooked foods and salads can be stored safely at room temperature until serving.

Most of the food handlers interviewed failed to specify the correct temperatures for storage of frozen foods and prepared salads; they also failed to specify the correct temperature to ensure thorough cooking.

On-the-job food safety training was given to 23 food handlers (14 in MRI and 9 in GAN). Food safety leaflets were distributed to all handlers and posters were used to demonstrate the importance of safe food handling practices. The importance of practising personal hygiene was illustrated through demonstrating the results of the bacteriological analysis of their hands after washing using various washing and drying routines. Also, the results of bacteriological analysis of food samples and swabs were used to draw the attention of the handlers to certain inadequacies during their food handling.

Post-training stage

At this stage the food safety knowledge and practices of all the food handlers in the 2 kitchens were reassessed using the food safety knowledge questionnaire and food handling checklist previously used in the pre-training stage to determine the effect of the training programme. Also, samples of patients' meals and swabs from food contact surfaces were again collected to evaluate the impact of training on their bacteriological quality.

Bacteriological examination

Two hundred and sixty (260) samples of patients' meals (160 of animal origin and 100 of plant origin) in addition to 52 swabs from food contact surfaces were examined, with the distribution illustrated in Tables 1 and 2. A sample of about 100 g or 100 mL from each item in the patients' meals was aseptically collected in a sterile plastic bag during serving. In case of swabs of large food utensils, an area of 100 cm^2 of their contact surfaces was swabbed using a sterile cotton swab moistened with sterile quarter strength Ringer solution, while the small food utensils, i.e. knives, spoons, etc. were aseptically immersed in sterile plastic bags containing 100 mL of this solution. The samples were transported as soon as possible to the laboratory using an insulated ice box containing an ice pack. They were subjected to the following bacteriological examination after making 10-fold serial dilutions [*10*].

- Estimation of aerobic mesophilic count [*11*]: standard plate count agar was drop-plated and incubated at 30 ºC for 72 hours
- Enumeration of coliforms using the most probable number (MPN), multiple tube technique and detection of faecal coliforms [*12*]: MacConkey broth was inoculated and incubated at 35–37 ºC for 24–48 hours and then several loopfuls of randomly chosen positive tubes were transferred into other tubes containing brilliant green bile broth and incubated at 44 ± 0.1 ºC and examined for gas production after 24–48 hours.
- Detection of coagulase-positive staphylococci [13]: Baird–Parker agar base supplemented with egg tellurite emulsion was drop-plated and incubated at 35–37 ºC for 24–48 hours. The suspected colonies were transferred into brain heart infusion and incubated for 24 hours at 37 ºC and then subjected to tube coagulase test [*14*].

Statistical analysis

Data were analysed using *SPSS*, version 9.0. The cut-off point for statistical significance was $P < 0.05$ and all tests were 2-sided. Kruskal–Wallis test was used to compare mean score percentages of different food safety knowledge parameters. Paired *t*-test was used to compare mean knowledge percentages and to compare the mean bacterial counts before and after training [*15*].

Results

Tables 1 and 2 show the bacteriological profiles of samples collected from the patient meals and the kitchen surfaces and utensils in the 2 hospitals before and after training. With regard to patients' meals, there was an overall improvement in their quality; there was a significant decrease in the aerobic mesophilic count of dairy products served in GAN and the chicken and eggs in MRI ($P < 0.05$). There was also a significant decline in coliform count of meat products, chicken and eggs, and stewed beans in MRI, and raw salads in both hospitals ($P < 0.05$) (Table 1).

The training resulted in marked improvements in the bacteriological profile of most swabbed food preparation surfaces in both hospitals. There was a drop in the value of the highest aerobic mesophilic count from 1.0×10^7 CFU (cooking pan) in GAN before training to 6.0×10^2 CFU after training. The highest coliform count dropped from 1200 MPN in a vegetable knife used in GAN to < 3 MPN after training. Also, the highest staphylococci count (8.0×10^5 CFU) in the meat chopping board used in MRI dec-

Table 1 **Microbiological profile of food samples collected from the kitchens pre- and post-training**

Food sample	Hospital	No. of samples[a]	Total aerobic mesophilic count[b] CFU/g or mL			Coliform count[b] MPN/g or mL			Faecal coliforms[c] %		Staphylococci Count[b] CFU/g or mL			Coagulase test %[c]	
			Pre	Post	PST	Pre	Post	PST	Pre	Post	Pre	Post	PST	Pre	Post
Animal origin															
Dairy products	MRI	20	1.6×10^4	1.3×10^4	0.304	27	9	1.860	10.0	20.0	1.2×10^3	1.2×10^3	0.146	0.0	0.0
	GAN	25	6.6×10^3	6.7×10^2	3.752*	16	6	1.809	0.0	0.0	9.1×10^2	3.2×10^2	1.956	12.0	0.0
Meat products	MRI	10	1.4×10^4	5.8×10^3	0.915	213	< 3	6.359*	30.0	0.0	1.5×10^3	5.7×10^2	0.906	0.0	0.0
	GAN	10	6.3×10^3	1.8×10^3	1.835	6	< 3	1.137	10.0	0.0	2.1×10^2	< 200	0.917	0.0	0.0
Chicken/eggs	MRI	10	1.3×10^4	4.9×10^2	3.367*	24	< 3	2.742*	10.0	0.0	4.1×10^2	2.0×10^2	2.204	0.0	0.0
	GAN	5	4.7×10^2	2.2×10^2	1.595	< 3	< 3	1.000	0.0	NCO	< 200	< 200	1.633	0.0	NCO
Total	MRI	40	1.3×10^4	4.9×10^2	3.367*	24	< 3	2.742*	10.0	0.0	4.1×10^2	2.0×10^2	2.204	0.0	0.0
	GAN	40	4.7×10^2	2.2×10^2	1.595	< 3	< 3	1.000	0.0	NCO	< 200	< 200	1.633	0.0	NCO
Plant origin															
Cooked	MRI	5	5.7×10^2	2.6×10^2	1.254	< 3	< 3	NS	NCO	NCO	< 200	< 200	NS	0.0	0.0
vegetables	GAN	5	4.0×10^2	3.0×10^2	0.440	< 3	< 3	NS	NCO	NCO	< 200	< 200	1.500	0.0	NCO
Jams	MRI	5	2.2×10^3	1.1×10^3	0.418	< 3	< 3	1.000	NCO	0.0	< 200	< 200	NS	NCO	NCO
	GAN	5	< 200	< 200	1.000	< 3	< 3	NS	NCO	NCO	< 200	< 200	1.000	20.0	NCO
Stewed beans	MRI	5	1.9×10^3	8.6×10^2	0.889	177	< 3	6.497*	20.0	0.0	< 200	< 200	1.000	0.0	0.0
	GAN	5	5.4×10^2	2.7×10^2	1.285	32	3	2.527	0.0	0.0	2.2×10^2	< 200	1.174	0.0	NCO
Bread	MRI	5	1.8×10^4	1.3×10^3	2.252	46	6	1.975	0.0	0.0	7.0×10^2	< 200	1.585	0.0	0.0
	GAN	5	1.3×10^3	1.8×10^3	0.746	< 3	5	1.534	0.0	0.0	< 200	< 200	1.000	20.0	0.0
Raw salad	MRI	5	9.9×10^4	4.8×10^3	2.972*	810	24	3.621*	20.0	0.0	1.3×10^3	4.9×10^2	0.885	40.0	0.0
	GAN	5	7.2×10^3	1.3×10^3	3.871*	88	4	3.698*	0.0	0.0	7.0×10^2	< 200	3.206*	0.0	0.0
Total	MRI	25	2.6×10^3	1.2×10^3	1.605	11	<3	4.096*	5.7	NCO	3.0×10^2	2.2×10^2	1.646	5.7	NCO
	GAN	25	8.7×10^2	4.0×10^2	2.469*	3	<3	1.478	0.0	0.0	2.5×10^2	1.9×10^2	2.513*	8.9	0.0

[a]*Each number of samples was collected before training and again after training.*

[b]*Values shown are the geometric mean.*

[c]*Percentage of positive samples.*

**Significant at* $P < 0.05$.

PST = paired-sample t-*test; CFU = colony forming units; MPN = most probable number; MRI = Medical Research Institute hospital; GAN = Gamal Abdel Nasser hospital; NCO = not carried out; NS = no statistics because the standard error equalled zero.*

reased to reach 1.2×10^3 after training (Table 2).

Food safety training of 23 food handlers in the 2 studied hospitals resulted in significant differences in the mean score percentages of all the different knowledge parameters in both hospitals after training ($P < 0.05$) (Table 3) and in an improvement in their overall food safety knowledge. The highest knowledge improvement in MRI was in food handling (310.1%) and in GAN it was in building and facilities (63.9%). The lowest improvement was in personal hygiene for both hospitals (78.0% and 33.5% respectively).

Table 4 shows that food safety practices improved after the training programme where the overall score increased to 72.6% with an improvement percentage of 37.9% in MRI and increased to 77.0% with an improvement of 17.0% in GAN. The lowest improvement percentage was in food handling in MRI (26.6%) and building and facility in GAN (8.2%) while the highest was in the equipment and utensils parameter in both hospitals (58.3% and 33.3% respectively).

Discussion

Experience from industrialized countries has shown that a comprehensive and well-funded regulatory system alone cannot prevent foodborne diseases. On the other hand, where regulatory and educational measures have been combined, they have been found to be effective in reducing foodborne diseases [*16*]. Before training, food handlers in GAN had greater food safety knowledge than those in MRI, while after training food handlers in both hospitals had approximately similar scores. Supervisors working in the GAN kitchen (there were 3 in GAN and 6 in MRI) were observed to be always directing the staff to improve all food safety related issues and this may account for the initial difference in knowledge between the hospitals. Moreover, all supervisors in GAN were university graduates compared to only half of the supervisors in MRI and hence could possess greater knowledge of food safety issues. A study on 290 food services staff in 36 hospitals in Italy showed that knowledge about foodborne pathogens was significantly higher among those with a higher educational level. Staff who had attended continuing education courses on food hygiene and hospital foodborne diseases had a significantly higher knowledge of safe temperatures for food storage [*17*].

Adhering to food safety measures among food services staff in hospitals is vital for the prevention of foodborne outbreaks [*9*]. There have been several reported food poisoning outbreaks in hospitals that were attributed to improper food handling. An outbreak of *Clostridium perfringens* food poisoning affected 17 of 44 (38.6%) patients in 2 hospital wards in the United Kingdom where the incriminated food was roast pork. This was because the cuts were too large and equipment to ensure rapid cooling of cooked meat was not installed [*18*]. In a teaching hospital in Spain, *S. enteritidis* infection was identified in 22 inpatients. After compliance with kitchen hygiene procedures, no more cases were detected [*19*]. In an outbreak of *S. enteritidis* phage type 4 food poisoning in a hospital for mentally handicapped people, deep-fried beef rissoles were implicated as the vehicle of infection and inadequate cooking was the contributing factor [*20*]. An outbreak of *S. enteritidis* gastroenteritis took place among tertiary care hospital workers in Mexico City and was probably caused by salmonella-contaminated foodstuffs again due to inadequate cooking [*21*].

Table 2 **Microbiological profile of swabs of various food utensils used in the kitchen pre- and post-training**

Food utensil	Hospital	No. of samples[a]	Total aerobic mesophilic count[b] CFU/g or mL wash or 100 cm²		Coliform count[b] MPN/g or mL wash or 100 cm²		Faecal coliforms[c] %		Staphylococci Count[b] CFU/g or mL wash or 100 cm²		Staphylococci Coagulase test %[c]	
			Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Meat knife	MRI	1	1.0×10^3	<200	7	<3	0	NCO	4.0×10^2	<200	0	NCO
	GAN	1	5.0×10^3	<200	200	<3	0	NCO	2.0×10^2	<200	0	NCO
Vegetable knife	MRI	1	4.0×10^3	<200	210	<3	0	NCO	2.0×10^3	<200	0	NCO
	GAN	1	5.0×10^4	2.0×10^2	1200	<3	0	NCO	2.0×10^3	<200	0	NCO
Meat chopping board	MRI	1	1.2×10^5	2.0×10^3	210	14	100	0	8.0×10^5	1.2×10^3	100	0
	GAN	1	4.0×10^3	8.0×10^3	200	7	0	0	1.0×10^3	<200	0	NCO
Salad chopping board	MRI	1	1.4×10^5	4.0×10^2	1200	4	0	0	1.4×10^4	6.0×10^2	0	0
	GAN	1	1.0×10^5	2.0×10^2	210	<3	0	NCO	1.4×10^4	4.0×10^2	0	0
Cooking pan	MRI	1	1.0×10^3	<200	70	<3	0	NCO	6.0×10^2	<200	0	NCO
	GAN	1	1.0×10^7	6.0×10^2	<3	<3	NCO	NCO	<200	1.0×10^3	NCO	0
Roasting pan	MRI	1	1.0×10^4	4.0×10^2	15	4	0	0	1.0×10^3	2.0×10^2	0	0
	GAN	1	1.4×10^3	2.0×10^4	9	<3	0	NCO	<200	2.0×10^2	NCO	0
Patient tray	MRI	5	2.6×10^2	<200	<3	<3	0	NCO	2.3×10^2	<200	0	NCO
	GAN	5	2.6×10^2	<200	<3	<3	NCO	NCO	<200	<200	0	NCO
Food distribution container	MRI	2	<200	<200	<3	<3	0	NCO	<200	<200	0	NCO
	GAN	2	<200	<200	<3	<3	NCO	NCO	<200	<200	NCO	NCO

[a]Each number of samples was collected before training and again after training.
[b]Values shown are the geometric mean.
[c]Percentage of positive samples.
CFU = colony forming units; MPN = most probable number; MRI = Medical Research Institute hospital; GAN = Gamal Abdel Nasser hospital; NCO = not carried out.

Table 3 **Mean score and improvement percentages of food safety knowledge parameters of food handlers pre- and post-training**

Parameter	Level of food safety knowledge							
	MRI (*n* = 14)				GAN (*n* = 9)			
	Mean score (SD)		*t*-test	Mean improvement (SD) %	Mean score (SD)		*t*-test	Mean improvement (SD) %
	Pre	Post			Pre	Post		
Building and facilities	55.6 (23.2)	94.4 (3.8)	6.338*	144.8 (225.7)	68.4 (22.2)	93.6 (2.3)	3.739*	63.9 (101.6)
Equipment and utensils	52.7 (27.8)	90.2 (16.4)	7.449*	138.6 (155.5)	72.2 (21.4)	93.1 (14.1)	2.887*	40.9 (56.0)
Personal hygiene	69.0 (27.7)	100.0 (0.0)	4.178*	78.0 (95.8)	81.0 (22.8)	96.3 (9.6)	1.880	33.5 (61.4)
Food handling	42.6 (26.7)	95.9 (4.3)	7.719*	310.1 (381.9)	69.9 (15.1)	95.3 (6.9)	5.213*	44.9 (48.9)
Overall knowledge	55.0 (27.4)	95.1 (9.2)	6.723*	124.9 (123.1)	72.9 (20.3)	94.6 (9.0)	3.792*	42.1 (58.7)
Kruskal–Wallis test	5.828	15.922*			5.159	12.315*		

**Significant at* P *< 0.05.*
MRI = Medical Research Institute hospital; GAN = Gamal Abdel Nasser hospital; SD = standard deviation.

Table 4 **Scores and improvement percentages of food safety practices before and after training**

Parameter	Level of food safety practice					
	MRI			GAN		
	Score %		Improvement %	Score %		Improvement %
	Pre	Post		Pre	Post	
Building and facilities	46.8	71.8	53.3	76.5	82.8	8.2
Equipment and utensils	40.0	63.3	58.3	50.0	66.6	33.3
Personal hygiene	72.4	93.1	28.6	79.3	93.1	17.4
Food handling	54.8	69.5	26.6	58.5	70.7	20.8
Overall practices	52.6	72.6	37.9	65.8	77.0	17.0

MRI = Medical Research Institute hospital;
GAN = Gamal Abdel Nasser hospital.

Our study showed that after launching the training programme, there was an improvement in the overall food safety practices and their associated parameters in both hospitals. GAN had better scores both before and after training, although it had a lower improvement percentage than MRI. Personal hygiene parameter had the highest score while equipment and utensils parameter had the lowest in the 2 hospitals both before and after training. Utensils used in the hospitals were made of aluminium and were washed with unheated tap water with detergent before training, while after training they were washed with warm water and detergent. Disinfection was not practised in either hospital before or after training. All utensils must be washed in warm water containing an adequate amount of suitable detergent and then disinfected [*22*]. Although, the improvement in the building and facility parameter in MRI was about 6 times higher than that of GAN, the latter hospital had higher mean score both before and after training as its kitchen building and facilities had been recently renewed.

One of the most important factors related to foodborne illnesses is the lack of knowledge on the part of food handlers or consumers and negligence (despite knowledge) in safe food handling [*16*]. Our study showed that there was a gap between food handlers' knowledge and food safety practices followed in the hospitals, where their knowledge score was usually higher than the corresponding practice score both before and after training. In fact, the knowledge scores were worse than the corresponding practice score only before training in the case of personal hygiene and food handling in MRI and the building and facility parameter in GAN. Another study that assessed the knowledge, attitudes, and practices of food services staff regarding food hygiene in government and private hospitals in Shiraz, Islamic Republic of Iran, showed that they had little knowledge regarding the pathogens that cause foodborne diseases and the correct temperature for the storage of hot or cold ready-to-eat foods. Most of them had positive attitudes, but disparity between attitude and practice was noted [*9*].

Items that contain a preponderance of ingredients of animal origin are likely to be excellent media for the multiplication of pathogenic bacteria and thus to be potentially dangerous [*23*].The improvement of the food safety knowledge and practices in both hospitals after launching the training programme consequently improved the bacteriological profile of most meals served to patients in both hospitals; however, the quality of patient meals of animal origin that were analysed in MRI were worse than that of meals served in GAN. Before training, faecal coliforms were detected in 30% of meat products, 10% of each of dairy products, chicken and eggs in MRI and in 10% of meat products in GAN. After training, such coliforms were not detected except in 20% of dairy products in MRI. Coagulase-positive staphylococci were detected before training in 12% of dairy products in GAN. This may be attributed to cross-contamination between ready-to-eat and raw foods mediated by the inadequately sanitized utensils and/or by the food handlers who were not following hygiene standards. It is worth mentioning that pasteurized milk samples in MRI were free of faecal coliforms before training although they were detected after training; the hospital changed the supplier of dairy products during the study, who unfortunately supplied the hospital with products of worse bacteriological quality.

Vegetables can become contaminated with microorganisms capable of causing human diseases while still in the fields or during harvesting or post-harvest handling in food services establishments [*24*]. Bacteriological analysis of the majority of patients' meals of plant origin revealed contamination of those served in MRI with higher microbial loads than those served in GAN both before and after training. The highest aerobic mesophilic, coliform and staphylococci counts were among raw salad served in MRI both before and after training. This may be attributed to the preparation of the salads using bare hands, the use of inadequately cleaned raw vegetables and their storage until service at a temperature that permits multiplication of bacteria. A study in a university hospital in France showed that 10% of patients' meals, all of which were salads, had total viable bacteria counts above the recommended limits [*25*]. Another study in a national hospital in Costa Rica revealed that all tested salad samples were positive for faecal coliforms [*26*]. In our study faecal coliforms and coagulase-positive staphylococci were detected in foods of plant origin only before training.

Poorly cleaned utensil and equipment surfaces harbour and promote the spread of microorganisms [*27*]. After training, there was an improvement in the bacteriological quality of most swabbed food contact surfaces. Neither faecal coliforms nor coagulase-positive staphylococci were detected on any surface except the meat chopping board in MRI before training. This chopping board also had the highest staphylococci count both before and after training and the highest coliform count after training. Despite changing the cleaning of the board after training to be with heated tap water and detergent instead of tap water alone, lack of adherence to this disinfection may explain this contamination. It is preferable to replace such wooden boards by more hygienic ones made of easily cleaned and sanitized materials.

The goal of any hospital caterer should be to provide food that meets nutritional requirements and is microbiologically safe. Food distribution to hospital wards plays a critical role in the safety of hospital food [*28*]. Moreover, for immunocompromised patients, the potential for food to cause infection is even greater and hospitals may impose dietary restrictions to limit pathogen exposure [*29*].

Our study showed that food safety knowledge and food handling practices in the 2 hospitals were unsatisfactory before training as was the bacteriological quality of the patient meals and kitchens surfaces/utensils. However, the training programme improved all aspects of the food safety issues assessed in both hospitals, although practice still lagged behind knowledge.

Given the importance of ensuring that hospital patients are not put at risk of foodborne infections, continuous on-the-job training should be launched for all food handlers in both food safety knowledge and practices. In addition implementation of a HACCP system would be beneficial to ensure the safety of the patient meals. Further studies on the handling practices of patient meals in the hospital wards are warranted.

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While all population groups are susceptible to foodborne disease, there are groups which are more susceptible. This note focuses on ٢ high-risk groups: pregnant women and infants, including the developing fetus. Hormonal changes during pregnancy affect the mother's immune system, resulting in decreased immune function and greater susceptibility. The developing fetus is susceptible to pathogens that may not cause illness in the mother. Infants and young children are more prone to foodborne disease because of their immature immune systems and developing organs, particularly kidney and brain. In addition, they consume more food in proportion to their body weight than adults; hence they have greater relative exposure to foodborne toxins and contaminants.

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