

National monitoring study on microbial contamination of food-contact surfaces in hospital kitchens in Poland

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Konecka-Matyjek E, Maćkiw E, Krygier B, Tomczuk K, Stoś K, Jarosz M. National monitoring study on microbial contamination of food-contact surfaces in hospital kitchens in Poland. *Ann Agric Environ Med*. 2012; 19(3): 457-463.

Abstract

Introduction and objective: The risk of food-borne infections in hospitalized patients with compromised immune systems is much higher and can also lead to more serious health consequences than among other population groups. Therefore, food hygiene within the hospital setting, should be handled in an appropriate manner. In 2008, there were 732 hospitals in Poland. It was estimated that 7.2 million hospitalized patients, with an average hospital stay of 5.9 days, benefited from hospital meals. On average, nearly half of the hospitals (ranging from 30%-50%, depending on the province) outsourced the preparation and delivery of meals to external service providers. The objective of this study was to survey the bacteriological contamination of selected food production and processing areas in hospital kitchens in Poland.

Materials and methods: The nationwide microbiological examination of food contact surfaces was performed in 10% of randomly selected hospital kitchens in all 16 provinces in Poland. A total of 3,277 samples were scientifically examined for hygiene indicator micro-organisms; namely, for Total Viable Count (TVC), *Enterobacteriaceae* count and coliforms, as well as for the presence of coagulase-positive staphylococci. The environmental samples were collected and examined according to European and Polish standards. All analyses were performed using Statistica version 6 software.

Results: The results revealed that food hygiene within the test sample was poor. Of the total samples taken for testing, 25.5% failed. The most common failures were related to excess TVC in swabs.

Conclusion: Testing shows that there is a need to improve the standard of hygiene in food handling areas of Polish hospitals.

Key words

hospital kitchens, food hygiene, food-contact surfaces

INTRODUCTION

Due to the increased risk of infections and food poisoning on hospital wards, ensuring microbiological safety in the main kitchens and ward kitchens of hospitals should be one of the priority issues, due to patients' compromised immune systems and their greater susceptibility to illness. This applies mainly to patients in extreme age groups, i.e. below one year of age and over 65 years of age, as well as patients, chronically ill or with serious compromised immune systems [1, 2, 3].

The proper nutrition and cleanliness maintenance in hospital kitchens is one of the conditions of medical treatment and recovery of hospitalized patients. This directly affects the likelihood of complications and the patients' length of stay in hospital. Both the malnutrition resulting from inadequate nutrition, as well as food poisoning and nosocomial infections can affect the duration of patient's stay in hospital. It is extremely important to define sources

of hazards during both the production and distribution of meals to ensure hygiene in hospital kitchens. Sampling of the production and processing environment can be a useful tool to identify and prevent the presence of pathogenic micro-organisms in foodstuffs [4].

The proper implementation of good hygienic and good production practices (GHP, GMP) as well as hazard analysis and critical control point system (HACCP) play a key role in the prevention of nosocomial food-borne infections [5, 6, 7].

In Polish hospitals the most popular systems of production and distribution of meals are: an on-site hospital kitchen using the traditional distributing system of heating trolleys and portioning of meals on the wards (a half-centralized system), and an on-site hospital kitchen using isothermal trays (centralized system). Increasingly, for preparing hospital meals outside-resource-using is observed. In Poland, all the systems of production and distribution of meals function according to the model of 'cook-hot holding'. It is anticipated that in the future, this model will be replaced by new ones ('cook-chill' and 'cook-freeze').

In Poland in 2008, according to the statistical yearbook, there was a total of 732 hospitals and in 2010 – 832 [8, 9]. Thus, an increasing tendency is observed. It is estimated that in

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Received: 26 April 2012; accepted: 02 July 2012



2008, 7.2 million hospitalized people benefited from hospital meals, with an average hospital stay of 5.9 day. Nearly half of the hospitals (from 30%-50%, depending on the province) used the services of external companies in preparing and delivering meals [10].

Data published by the Chief Sanitary Inspectorate (CSI) [10] show that the situation in the maintenance of cleanliness in hospital kitchens in 2006-2009 was not satisfactory. Such a situation was also identified by the Polish Supreme Chamber of Control (SCC) in 2008 [11]. The unsatisfactory sanitary conditions in hospital main and ward kitchens, as well as poor work organization, caused problems in the preparation of safe meals for the patients [10].

The objective of this study was to survey the bacteriological contamination in selected food production and processing areas in hospital kitchens in Poland.

MATERIAL AND METHODS

In order to assess the microbiological safety of hospital kitchens in Poland, food-contact surfaces were examined. The survey was performed in 102 randomly selected hospital kitchens in all 16 provinces in Poland, which represents a sample of more than 10% on a national scale. Microbiological swabs were taken in each hospital kitchen three times in the period from January – September 2009. A total of 3,277 samples were examined, including 2,204 in main kitchens and 1,073 in ward kitchens. The swabs were collected in hospital kitchens from food-contact surfaces and employees' hands in the following areas: cold and hot kitchens, dishwashing tableware rooms, dishwashing utensils rooms, portioning and serving areas, and ward kitchens. The surfaces were potentially 'clean' and were examined before food production activities began.

The study was designed by the National Food and Nutrition Institute in 2008. The environmental samples were collected according to the international standard ISO 18593:2004 [12] by employees of the Polish State Sanitary Inspection, and examined in the laboratories of the State Sanitary Inspection for hygiene indicator micro-organisms; namely, for the Total Viable Count (TVC), *Enterobacteriaceae*, and coliform presence, as well as coagulase-positive staphylococci, according to the following standards:

- Enumeration of microorganisms – Colony-count: EN ISO 4833:2003 [13]
- Enumeration of *Enterobacteriaceae*: ISO 21528-2:2004 [14]
- Detection of coliforms: ISO 4832:2006 [15]
- Detection of coagulase-positive staphylococci: EN ISO 6888-3:2003+AC: 2005 [16].

The results were collected, elaborated and interpreted by the National Food and Nutrition Institute. In addition, statistical analysis were performed using a chi-square test, with significance defined at $p < 0.05$ or $p < 0.0001$. All analyses were performed using Statistica version 6 software (Statsoft, Inc., Tulsa, OK, USA).

RESULTS

Of the 3,277 samples surveyed, a total of 837 (25.5%) samples were disqualified (Tab. 1). Differences were found concerning the number of samples disqualified between

provinces. The values for the percentage of disqualified samples ranged from 3.2% (in the Kujawsko-Pomorskie province) to 48.6% (in the Mazowieckie province) for all main kitchens, and from 0% (Łódź province) to 58.3% (Opole province) for all ward kitchens (Tab. 4).

Contamination of various types of surfaces and employees' hands in selected hospital kitchens in Poland, in total. Among all scientifically examined food-contact surfaces in the hospital kitchens, the most contaminated were employees' hands (28.9% of samples contaminated), followed by surfaces of food production utensils and other equipment (28.4% of samples), and finally, food-contact work surfaces (22.4% of samples).

Excessive amounts of TVC (26.1% of samples) and the presence of coagulase-positive staphylococci (2.0% of samples) were more frequently reported on employees' hands than on other types of surfaces. In turn, bacilli from the *Enterobacteriaceae* family (5.2% of samples) and coliforms (3.5% of samples) were more frequently isolated from surfaces of food production utensils and other equipment.

The significant statistical differences between the contamination of food-contact work surfaces and the food production utensils and other equipment, as well as the food-contact work surfaces and employees' hands, were found at a significance level of $p < 0.0001$. No significant differences were noted in contamination between food production utensils, other equipment, and employees' hands (Tab.2).

Contamination of various types of surfaces and employees' hands in selected hospital kitchens in Poland, including the division of hospital-run kitchens and outside catering companies. A total of 1,311 samples were examined, taken in the main kitchens operated by the hospitals, and 893 samples taken in kitchens operated by external catering companies (Tab. 3).

There were significant differences (significance level $p < 0.0001$) between the percentage of disqualified samples taken from food production utensils and other equipment in the main kitchens operated by the hospitals, and those operated by external companies. A similar dependency was found for disqualified samples taken from employees' hands.

No significant differences were found between the percentage of disqualified samples taken from the food-contact surfaces in the main kitchens operated by the hospitals, and in the kitchens operated by outside companies. The largest number of disqualified samples resulting from an excess of acceptable levels for TVC was, respectively, 25.3% for kitchens operated by hospitals and 24.0% for those operated by outside companies. Coagulase-positive staphylococci (2.2% of samples) and coliforms (3.6% of samples) were isolated in kitchens operated by external caterers more often than in the kitchens run by the hospitals. However, a disqualified number of bacilli from the *Enterobacteriaceae* family were found more frequently in the kitchens operated by the hospitals (4.3% of samples) (Tab. 3).

In the kitchens operated by the hospitals, surfaces of food production utensils and other equipment proved to be the most contaminated (28.5% of samples). On these surfaces, compared to other types of surfaces, an excess was found of the acceptable number of *Enterobacteriaceae* (6.6% of samples) and the presence of coliforms (3.6% of the samples).



Table 1. Microbiological evaluation of cleanliness of food-contact work surfaces, food production utensils and other equipment as well as employees' hands in selected main hospital kitchens versus kind of province in Poland

No.	Provinces	Main kitchens				Ward kitchens				No. of hospitals in each province
		Total No. of samples	Disqualified samples		Total No. of samples	Disqualified samples				
			No.	%		No.	%			
1	Dolnośląskie	180	54	30.00*	60	10	16.67***	9		
2	Kujawsko-pomorskie	126	4	3.17*	67	7	10.45***	4		
3	Lubelskie	121	19	15.70* ³	51	6	11.76***	5		
4	Lubuskie	90	12	13.33*	54	14	25.93**	3		
5	Łódź	185	12	6.49* ¹	36	0	0.00**	6		
6	Małopolskie	181	30	16.57* ⁵	87	11	12.64***	7		
7	Mazowieckie	319	155	48.59*	163	51	31.29**	10		
8	Opole	21	9	42.86*	12	7	58.33**	2		
9	Podkarpackie	180	61	33.89* ⁷	108	50	46.30**	17		
10	Podlaskie	59	4	6.78* ²	12	1	8.33**	3		
11	Pomorskie	120	25	20.83*	54	11	20.37**	4		
12	Śląskie	240	112	46.67*	165	49	29.70**	13		
13	Świętokrzyskie	90	8	8.89*	44	7	15.91***	3		
14	Warmińsko-mazurskie	120	19	15.83* ⁴	72	10	13.89**	4		
15	Wielkopolskie	82	24	29.27*	52	21	40.38**	9		
16	Zachodnio-pomorskie	90	30	33.33* ⁶	36	4	11.11***	3		
Country (in total)		2,204	578	26.23	1,073	259	24.14	102		

* Values for disqualified samples in total were significantly different in main kitchens (χ^2 test, $p < 0.0001$) with the exclusion of the relation between values 1 and 2, 3 and 4, 3 and 5, 4 and 5, 6 and 7

** Values for disqualified samples in total were significantly different in ward kitchens (χ^2 test, $p < 0.0001$) with the exclusion of the relation between values 1 and 2, 2 and 3, 3 and 4, 5 and 6.

Table 2. Contamination of various types of surfaces in selected hospital kitchens in Poland, in total

Kind of the surfaces	Total samples		Disqualified samples									
			Total		TVC (Total Viable Count)		Enterobacteriaceae count		Coliforms presence		Coagulase-positive staphylococci presence	
	Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Work surfaces	1622	49.50	364	22.44*	347	21.39	30	1.85	32	1.97	15	0.92
Utensils and other equipment	970	29.60	275	28.35*	248	25.57	50	5.15	34	3.51	5	0.52
Staffs' hands	685	20.90	198	28.91*	179	26.13	24	3.50	19	2.77	14	2.04
In total	3277	100.00	837	25.54	774	23.62	104	3.17	85	2.59	34	1.04

* Values for disqualified samples in total taken from food-contact work surfaces and surfaces of utensils and other equipment were significantly different, and values for disqualified samples in total taken from food-contact work surfaces and employees' hands working in direct contact with food were significantly different (χ^2 test, $p < 0.0001$).

The employees' hands were also characterized by a high degree of contamination (25.6% of samples), resulting mainly from the presence of an excessive level of TVC (26.6% of samples).

In turn, in kitchens operated by external catering companies, the personnel's hands were the most contaminated (36.1% of samples). On their surfaces, an excessive level of TVC (31.3% of samples) and coagulase-positive staphylococci (4.9% of samples) were reported more frequently than on the other tested surfaces. Surfaces of food production utensils and equipment were less contaminated (25.0% of samples). Swabs taken from the food production utensils and other equipment contained an excessive number of *Enterobacteriaceae* (3.5% of samples) and coliforms (4.8% of samples) more frequently than those taken from the other types of surfaces.

Similar to the main hospital-run kitchens, in kitchens operated by the catering companies food-contact work surfaces proved to be the least contaminated areas (24.0% of samples).

Contamination of various types of surfaces and employees' hands in selected hospital kitchens, including the division of the main and ward kitchens. Studies have shown that in main kitchens operated both by hospitals and external companies, as well as in ward kitchens, the percentage of disqualified samples collected from food-contact work surfaces, food production utensils and other equipment and employees' hands coming into contact with food, was similar and amounted, respectively, to 26.2% and 24.1% (Tab. 4). In all the sampled kitchens, both main and ward, there was the highest percentage of samples containing an excessive level of TVC, amounting to 24.7% and 21.3%, respectively.

Food-contact work surfaces and employees' hands coming into contact with food in the main kitchens, compared to the ward kitchens, were characterized by a higher contamination. In these kitchens, the percentage of samples containing an excessive number of *Enterobacteriaceae* bacilli and the presence of coliforms was, respectively, 3.5% and 3.2%. In



Table 3. Contamination of various types of surfaces and employees' hands in selected hospital kitchens in Poland, including the division of kitchens operated in hospitals on their own and by outside catering companies

Hospital main kitchens, including:	Kind of the surfaces	Total samples		Disqualified samples									
				Total		TVC (Total Viable Count)		Enterobacteriaceae count		Coliforms presence		Coagulase-positive staphylococci presence	
		Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Main kitchens operated in hospitals on their own	Work surfaces	697	31.62	174	24.96	174	24.96**	21	3.01***	18	2.58	0	0.00*****
	Utensils and other equipment	411	18.65	117	28.47*	103	25.06**	27	6.57***	15	3.65****	2	0.49
	Staffs' hands	203	9.21	52	25.62*	54	26.60**	9	4.43***	5	2.46****	1	0.49*****
	Total (1)	1311	59.48	343	26.16	331	25.25	57	4.35	38	2.90	3	0.23
Main kitchens operated by outside catering companies	Work surfaces	437	19.83	105	24.03	95	21.74**	5	1.14***	11	2.52	11	2.52*****
	Utensils and other equipment	312	14.16	78	25.00*	74	23.72**	11	3.53***	15	4.81****	2	0.64
	Staffs' hands	144	6.53	52	36.11*	45	31.25**	4	2.78***	6	4.17****	7	4.86*****
	Total (2)	893	40.52	235	26.32	214	23.96	20	2.24	32	3.58	20	2.24
In total (1 + 2)		2204	100.00	578	26.23	545	24.73	77	3.49	70	3.18	23	1.04

*Values for disqualified samples in total taken from surfaces of utensils and other equipment were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies, and values for disqualified samples in total taken from employees' hands were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies (χ^2 test, $p < 0.0001$)

**Values for disqualified samples (due to excessive level of TVC) taken from food-contact work surfaces were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies, and values for disqualified samples (due to excessive level of TVC) taken from employees' hands were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies (χ^2 test, $P < 0.0001$), and values for disqualified samples (due to excessive level of TVC) taken from surfaces of utensils and other equipment were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies (χ^2 test, $p < 0.05$)

***Values for disqualified samples (due to excessive Enterobacteriaceae count) taken from food-contact work surfaces were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies, and values for disqualified samples (due to excessive Enterobacteriaceae count) taken from surfaces of utensils and other equipment were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies, and values for disqualified samples (due to excessive Enterobacteriaceae count) taken from employees' hands were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies (χ^2 test, $p < 0.0001$)

****Values for disqualified samples (due to coliforms presence) taken from surfaces of utensils and other equipment were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies, and values for disqualified samples (due to coliforms presence) taken from employees' hands were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies (χ^2 test, $p < 0.0001$)

*****Values for disqualified samples (due to coagulase-positive staphylococci presence) taken from food-contact work surfaces were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies, and values for disqualified samples (due to coagulase-positive staphylococci presence) taken from employees' hands were significantly different in kitchens operated in hospitals on their own and kitchens operated by outside catering companies (χ^2 test, $p < 0.0001$)

Table 4. Contamination of various types of surfaces and employees' hands in selected hospital kitchens in Poland, including the division of the main and ward kitchens

Hospital kitchens, including:	Kind of the surfaces	Total samples		Disqualified samples									
				Total		TVC (Total Viable Count)		Enterobacteriaceae count		Coliforms presence		Coagulase-positive staphylococci presence	
		Number	%	Number	%	Number	%	Number	%	Number	%	Number	%
Main kitchens	Work surfaces	1134	34.6	279	24.6*	269	23.7	26	2.3****	29	2.6***	11	1.0
	Utensils and other equipment	723	22.1	195	27.0*	177	24.5**	38	5.3	30	4.1***	4	0.6
	Staffs' hands	347	10.6	104	30.0	99	28.5**	13	3.7	11	3.2	8	2.3
	Total (1)	2204	67.3	578	26.2	545	24.7	77	3.5	70	3.2	23	1.0
Ward kitchens	Work surfaces	488	14.9	85	17.4*	78	16.0	4	0.8****	3	0.6***	4	0.8
	Utensils and other equipment	247	7.5	80	32.4*	71	28.7**	12	4.9	4	1.6***	1	0.4
	Staffs' hands	338	10.3	94	27.8	80	23.7**	11	3.3	8	2.4	6	1.8
	Total (2)	1073	32.7	259	24.1	229	21.3	27	2.5	15	1.4	11	1.0
In total (1 + 2)		3277	100.0	837	25.5	774	23.6	104	3.2	85	2.6	34	1.0

* Values for disqualified samples in total, taken from food-contact work surfaces were significantly different in main kitchens and ward kitchens, and values for disqualified samples in total, taken from surfaces of utensils and other equipment were significantly different in main kitchens and ward kitchens (χ^2 test, $p < 0.01$)

** Values for disqualified samples (due to excessive level of TVC) taken from food-contact surfaces of utensils and other equipment were significantly different in main kitchens and ward kitchens, and values for disqualified samples (due to excessive level of TVC), taken from employees' hands were significantly different in main kitchens and ward kitchens (χ^2 test, $p < 0.05$)

*** Values for disqualified samples (due to coliforms presence) taken from food-contact work surfaces were significantly different in main kitchens and ward kitchens (χ^2 test, $P < 0.0005$), and values for disqualified samples (due to coliforms presence) taken from food production utensils and other equipment were significantly different in main kitchens and ward kitchens (χ^2 test, $p < 0.001$)

**** Values for disqualified samples (due to excessive Enterobacteriaceae count) taken from food-contact work surfaces were significantly different in main kitchens and ward kitchens (χ^2 test, $p < 0.01$)



turn, the percentage of samples contaminated with coagulase-positive staphylococci was equal in both the main kitchens and ward kitchens – 1%.

In the main kitchens the staff's hands were the most contaminated (30% of disqualified samples). In the collected material, an excess of the acceptable level of TVC (28.5% of samples), as well as the presence of coagulase-positive staphylococci (2.3% of samples) was found more frequently than on other types of surfaces. The surfaces of utensils and equipment were slightly less contaminated (27.0% of samples). Nonetheless, the exceeded number of *Enterobacteriaceae* (5.3% of samples) and presence of coliforms (4.1% of samples) were found on them more often than on other surfaces. Food-contact work surfaces were found to be the least contaminated (24.6% of samples).

In ward kitchens, surfaces of food production utensils and other equipment were the most contaminated (32.4% of samples). In the collected material, an excess of acceptable level of TVC (28.7% of samples) as well as *Enterobacteriaceae* count (4.9% of samples) was identified more frequently than on other types of surfaces. Employees' hands were slightly less contaminated (27.8% of samples). However, the presence of coliforms (2.4% of samples) and coagulase-positive staphylococci (1.8% of samples) were found on them more often than on other surfaces. As in the case of the main kitchens, in the ward kitchens, food-contact work surfaces were found to be the least contaminated (17.4% of samples). There were significant differences between the percentage of disqualified samples taken from the food-contact work surfaces in the main kitchens and ward kitchens (significance level of $p < 0.0001$), and also the percentage of disqualified samples taken from food production utensils and other equipment (significance level of $p < 0.01$). No significant differences were found between the percentage of disqualified samples taken from the staffs' hands, working in the main and ward kitchens (Tab. 4).

DISCUSSION

In accordance with European Commission Regulation (EC) No. 2073/2005 of 15 November 2005 on microbiological criteria for foodstuffs [4], food-contact surfaces are a major concern for food service facilities in controlling the spread of food-borne pathogens. Food service areas are considered critical to health, therefore the bacteriological quality of these surfaces, as well as non-food services in hospital kitchens, must be assessed.

The results of the presented survey were interpreted in accordance with the applicable criteria of the National Institute of Public Health/National Institute of Hygiene in Poland [17]. According to this Institute, the food-contact surface is considered to be sufficiently clean if there are no more than: 10 Colony-Forming-Unit (CFU) in 1 cm² of food-contact work surface, 10² CFU in total surface area of food production utensils and other equipment, and 10³ CFU on employees' hands, and additionally, if no coliforms and coagulase-positive staphylococci are present. Based on these criteria, there were significant differences found in the degree of contamination of food-contact work surfaces, surfaces of food production utensils and other equipment, and staffs' hands working in direct contact with food in the various provinces in Poland. The highest percentage of disqualified

samples in the main kitchens were found in Mazowieckie, and the lowest in Kujawsko-Pomorskie province. On the other hand, food preparation surfaces located in ward kitchens proved to be the most contaminated in the Opole province, and the lowest in Łódź province. These differences may result from the different degree of implementation of food safety systems – Good Hygienic Practice (GHP) and Hazard Analysis and Critical Control Point (HACCP) in these provinces. The Polish Chief Sanitary Inspectorate's reports from 2006-2010, and information on the control of nutrition and maintaining cleanliness in public hospitals in Poland published by the SCC, show that many Polish hospitals failed to implement procedures based on HACCP principles, or the degree of their implementation was not satisfactory [10, 11].

The results obtained from microbiological studies of food-contact surfaces and employees' hands working in contact with food in the various provinces in Poland are extremely important because of the lack of current data within this area. By 2005, the State Sanitary Inspectorate performed these studies as part of its routine operations. However, according to the current tendency to transfer the responsibility for food safety onto the producer, microbiological studies of food-contact surfaces are performed by the official food control only occasionally. Analysis of the results of the presented survey indicates the need for periodic monitoring studies in this field. The necessity of such actions also confirms the findings of the report of the SCC 'Information on the results of the nutrition and cleanliness in public hospitals', published in March 2009 [11]. The report shows that the maintenance of cleanliness in Polish hospitals was unfavourable due to the large number of irregularities and deficiencies.

The level of microbiological contamination of food-contact work surfaces, surfaces of food production utensils and other equipment and employees' hands found in our study is similar to the results obtained by other authors. Cosby et al. [18] showed that the degree of bacterial contamination was dependent, among other things, on the sampling area. The study performed by Griffith et al. [19] found that the most contaminated areas in the ward were the kitchens and toilets. The ward kitchen area was the site with the highest number of enterobacteria – 40 and even 10² cfu/cm².

The results of own research show that the employees' hands and surfaces of food production utensils and other equipment were the most contaminated. On the staffs' hands there was found an excess of the acceptable level of TVC and the presence of coagulase-positive staphylococci more frequently than on other types of surfaces. In contrast, *Enterobacteriaceae* bacilli, as well as coliforms, were isolated more often from the food production utensils and equipment surfaces. Cosby et al. [18] underline in their study that staffs' hands are a source of coli bacteria contamination. Among others, the wearing of jewellery by employees who are in direct contact with food can be the source of contamination of their hands. This was also highlighted in the SCC report [11] and Acikel et al. also draw attention to issue [20]. The authors state that wearing jewellery while working makes proper cleaning and disinfection of hands impossible and increases the risk of the presence of pathogens [21]. Therefore, it creates the possibility of transferring the physical and microbiological contamination to food.

As pointed out by Griffith et al. [19], the bigger microbiological contamination of food production utensils



and other equipment and employees' hands may be caused by problems with the effectiveness of cleaning hard-to-reach places, the inadequate frequency of cleaning, or the ineffective method of cleaning. Thus, food production utensils, other equipment, and all the hard-to-reach places can be a potential risk of food contamination, directly through their contact with food or indirectly via the hands of staff and other potentially clean surfaces.

The report by the European Food Safety Authority (EFSA) [22, 23, 24] shows that serious outbreaks of cases of confirmed food-borne infection were found in hospitals and other health care facilities in EU countries. Such cases are infrequent (4.5% in 2007, 4.8% in 2009 and 0.6% in 2010); however, they affect a significant number of patients. According to EFSA data, in 2009, out of total (324) *Salmonella* food-borne outbreaks, 1.2% were notified in hospitals or medical care facilities in EU countries. Data from 2009 also provides information on an outbreak in a hospital caused by *Campylobacter* [23].

Numerous infection outbreaks, in which the source of infection was food and hospital food service areas, including hands of employees, have also been reported [6, 25, 26]. Bornemann et al. [27] describe a food-borne outbreak of *Salmonella* serotype Saintpaul in a children's hospital. Epidemiological investigation revealed that an enteral feeding formula mixed by the hospital was the source of infection. The author stresses the importance of proper hand hygiene and maintaining vigilance during the preparation of formulae. There were also found in hospitals cases of eating and drinking by staff in patient care areas, which is supposed to be prohibited. Hardy et al. [28] describes nosocomial listeriosis case associated with tuna fish salad handled in a hospital kitchen. Although no violations were found in the food service area, the authors underline that the Prerequisite Programmes (PRPs) should be followed. Also emphasized was the necessity of infection prevention education for employees who are in direct contact with food, and awareness of food-borne illness among infection prevention personnel. A serious *Clostridium perfringens* outbreak in a hospital is reported by Linscott [29] where chicken salad was found to be the vehicle of infection. Lund and O'Brien [30] cite a review of series examples of food-borne outbreaks in hospitals and other healthcare settings which, in many cases, resulted in death. The most frequent factors leading to outbreaks were: cross-contamination in the kitchen, no HACCP system implemented, an improper food cooling system, infected food handler, dirty equipment, underheated meals of raw egg origin, and consequential contamination of ready-to-eat foods. Therefore, as the authors emphasize, prevention of food-borne infections in hospitals and other healthcare and medical care facilities is essential. Proper implementation, current and periodical verification of PRPs (GHP, GMP) and HACCP, including food safety policy in hospitals, are the key for their prevention.

Each year in Poland, outbreaks of singular cases of food infection are diagnosed [31, 32, 33], caused by consuming food produced in hospital kitchens. However, as Baumann-Popczyk and Sadkowska-Todys [34] report, in 2009, out of 451 notified food-borne outbreaks involving 5,118 cases (outbreaks involving 4 person or more) and 140 food-borne outbreaks (involving 2-3 persons), 25.1% was nosocomial and involved 22.3% cases. In 2009, hospitals next to household settings were the most common places where food-borne outbreaks were notified.

In the literature, there is no separate data on confirmed food-borne infections caused by poor sanitary kitchen facilities. However, as the authors state in the presented study, there is no doubt that environmental surfaces, including those in hospital kitchens as well as food handlers' hands, can be the sources of spreading pathogens which can lead to nosocomial infections [19, 35, 36]. Expressed succinctly, this confirms the need to monitor the state of cleanliness of hospital kitchens.

CONCLUSIONS

Out of the total number of samples taken for testing, 25.5% were found to be contaminated. Excessive amounts of TVC were more frequently reported in examined environmental samples. No significant differences were found between the percentage of disqualified samples taken in the main kitchens operated by the hospitals, and those operated by external companies. The level of microbiological contamination of food-contact work surfaces, surfaces of food production utensils and other equipment, and employees' hands in the main kitchens as well as in ward kitchens, was found to be comparable. Of all the examined food-contact surfaces the most contaminated were:

- surfaces of food production utensils and other equipment (in the kitchens operated by the hospitals – 28.5% of samples);
- personnel's hands (in kitchens operated by outside catering companies – 36.1% of samples).

Significant differences were also found concerning the number of samples disqualified between provinces. The presented survey shows that there is a need to improve the standard of hygiene in food handling areas of Polish hospitals.

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