SYLWIA NOWICKA, MAGDALENA ZDZIEBŁO, KINGA SKRZYPEK,
URSZULA KOSIKOWSKA, ANNA MALM

Kampylobakterioza na tle sytuacji epidemiologicznej w Polsce i w innych krajach europejskich

Campylobacteriosis – the epidemiological situation in Poland and other European countries

Streszczenie

Zatrucia i zakażenia przewodu pokarmowego należą do najczęstszych infekcji występujących na całym świecie. Jednym z czynników epidemiologicznych zaburzeń lub chorób przewodu pokarmowego u ludzi są pałeczki *Campylobacter* spp., z których najistotniejsze znaczenie epidemiologiczne mają *Campylobacter coli* i *C. jejuni*. Są one zdolne wywoływać u ludzi ostrą zakaźną chorobę zwaną kampylobakteriozą. W znaczącej części przyczyną kampylobakteriozy jest spożycie mięsa drobiowego i jego przetworów bez odpowiedniej obróbki termicznej, dlatego bakterie te zaklasyfikowano do grupy odzwierzęcych patogenów przenoszonych w żywności (ang. food-borne zoonotics pathogens). Obecnie pałeczki *Campylobacter* spp. oraz wiele innych bakterii wykazuje wzrastającą oporność na antybiotyki i chemioterapeutyki. Lekooporność tej grupy drobnoustrojów zaczyna pojawiać się już globalnie. Większość szczepów *Campylobacter* spp. jest oporna na cefalotynę i fluorochinolony, ale wrażliwa na kwas nalidyksowy. Dla przypadków trudniejszych zakażeń tymi bakteriami zarezerwowane są zazwyczaj makrolidy i tetracykliny. Jednak wzrastająca oporność szczepów *C. coli* i *C. jejuni* na fruorochinolony, tetracykliny i erytromycynę wpływa znacząco na efektywność terapii antybiotykowej. Niepokojącym faktem jest także to, że rocznie na terenie Unii Europejskiej zgłaszanych jest ponad 10 000 przypadków kampylobakterioz – około 6 zakażeń na 100 000 osób w populacji, wielokrotnie kończących się śmiercią (od 2006 do 2011 roku zmarło 266 osób). W polskich szpitalach z powodu objawów zakażenia *Campylobacter* spp. w latach 2004-2011 hospitalizacji poddano łącznie 1027 pacjentów, a 15 grudnia 2012 roku zapadalność na kampylobakteriozę przekroczyła próg 1.00 na 100 000 osób.

Dane epidemiologiczne wyraźnie sugerują poważny problem kampylobakteriozy w Polsce. Zajmuje ona coraz wyższe miejsca w klasyfikacji chorób zakaźnych występujących w naszym kraju.

Abstract

Food poisoning and infections are the most common disorders that now occur all over the world. One of the human epidemiologic factors of gastrointestinal tract disorders and diseases are *Campylobacter* spp. rods, among which *Campylobacter coli* and *C. jejuni* are the most significant. These bacteria are able to cause a contagious disease called the campylobacteriosis. Consumption, especially of poultry meat without an adequate heat treatment, became the greatest cause of an illness, and that was the reason why *Campylobacter* spp. were classified as a food-borne zoonotic pathogens. Nowadays, *Campylobacter* spp. and many other bacteria prove to be more and more resistant to antibiotics and chemotherapeutics. Drug resistance in this group of microorganisms begins to emerge globally and due to this fact, the WHO described it as a serious problem. Most of the *Campylobacter* spp. strains are resistant to cephalothin and fluoroquinolones, but are sensitive to a nalidixic acid. Macrolides and tetracyclines are usually used with more complicated infection cases. However, the increasing *C. coli* and *C. jejuni* resistance to quinolones, tetracyclines and erythromycin, influences the effectiveness of antibiotic therapy. Disturbing is the fact that in the European Union over 10,000 cases of campylobacteriosis are reported – about 6 infections per 100,000 population, often with fatal end (in the period of 2006-2011, 266 people died). Because of signs of *Campylobacter* spp. infection, 1027 people in Poland were hospitalized between 2004-2011, and on the 15th December 2012 the campylobacteriosis incidence rate exceeded the threshold of 1.00 per 100,000 population.

Epidemiologic data clearly indicate the significance of campylobacteriosis problem in Poland. The disease occupies higher and higher places in general classification of infectious diseases appearing in our country.

Słowa kluczowe: kampylobakterioza, *Campylobacter* spp., epidemiologia, choroba zakaźna.

Keywords: campylobacteriosis, *Campylobacter* spp., epidemiology, infectious disease.

Department of Pharmaceutical Microbiology, Faculty of Pharmacy with Medical Analytics Division, Medical University of Lublin, Poland

INTRODUCTION

Food poisoning and gastrointestinal infections are the most common disorders which now occur in various environments all over the world. These infections are reported throughout the year in Poland but most of them develop in summer time. It is favored by easiness of microorganisms proliferation in higher temperatures and a role of insects in transmitting them. Epidemiological terms distinguish sporadic, family and mass morbidity (epidemics). The way of food preparation, transport, storage and protection against insects and other vectors of microbial and etiological factors influence spreading it further. Infectious food poisonings are acute disease states, caused by a consumption of food containing a huge amount of pathogenic microbes or their metabolites, mostly bacterial toxins [1-3].

Campylobacter spp. characteristics

One of the human epidemiological factors of food poisoning and gastrointestinal infections are *Campylobacter* spp. rods. The first infection cases caused by these bacteria were observed by Theodor Escherich in 1886. John McFadyean again recognized the presence of similar bacteria in patients with gastrointestinal tract diseases, which were described as vibrio-shaped spiral microbes and were given a name *Vibrio fetus*. The infection caused by these bacteria was identified in 1959 in children with acute diarrhea symptoms. In 1963 new genus of *Campylobacter* spp. was separated as the most probable etiologic factor connected with the digestive system infections [4]. However, due to culture difficulties and a lack of adequate media, isolation of the first *Campylobacter* spp. species from feces of patients with acute colitis was successful only 9 years later. One year later, in 1973 – *Vibrio fetus* was reclassified to the newly created genus [5]. Among *Campylobacter* spp. there are about 20 different species and subspecies now, but the most important epidemiological factors are *Campylobacter* coli and *C. jejuni* [6].

Campylobacter spp. are Gram-negative, oblong, capable of movement and not producing spores bacteria, which can appear in three different morphological stages: helical, coccus or cocoidal [6]. These bacteria are even more sensitive to climate changes than *Salmonella* spp. rods. Higher temperature, freezing and thawing, high oxygen concentration, pH value changes and especially drying, significantly reduce the survival of *Campylobacter* spp., whereas freezing does not eliminate them from infected food. Ability to proliferate is limited to the host organism – these bacteria only exist in food products [7,8]. Cellular factors (lipoprotein A jejuni JlpA, fibronectin-binding proteins, secreted proteins Cia, *Campylobacter* containing vacuoles CCVs, ability to epithelium adhesion) as well as extracellular factors (cytotoxins – cytotonic CCT and CTON, cytolethal distending toxin CDT, *Campylobacter jejuni* toxin CJT, enterotoxins – heat-labile toxin LT and Shiga-like toxin Sht, mobility, chemotaxis) determine their pathogenicity [9-13].

Campylobacteriosis – symptoms

Campylobacter genus rods were classified as the food-borne zoonotic pathogens and were thought to be bacteria harmless to humans and colonizing animal organisms [14]. Over time, it has turned out that these rods are able to induce human acute infectious disease called campylobacteriosis.

Campylobacteriosis is a great example of zoonotic disease that humans can be infected with directly from animals (especially those remaining in close contact – farmers, veterinarians, etc.). The disease can have a form of a sporadic or endemic food poisoning and infections. Most of cases are caused by a consumption of poultry meat and its products without proper heat treatment or occasional consumption of other kinds of meat (pork or beef), spinach, lettuce, turnips, potatoes or onions to a small degree. Epidemic infections primarily appear as a result of drinking water and raw or inadequately pasteurized milk contaminated by *Campylobacter* spp. [6,15-17].

In human organism, campylobacteriosis induces mainly severe diarrhea (often bloody), nausea, vomiting, abdominal pain, headache and fever. Disease in adults is a self-limiting infection and lasts no longer than 2 weeks. Much less frequently, besides typical symptoms, severe gastrointestinal bleeding, cholecystitis and appendicitis, toxic megacolon, ulcerative or pseudomembranous enterocolitis, urinary tract infections, endocarditis, abscesses or sepsis, are observed [5,6]. Bacteriemia and chronic diarrhea are very rare and occur most frequently in patients from extreme age groups, with immunodeficiency or with chronic course of disease. In this group of patients a Guillain-Barr syndrome or its variant – Miller-Fischer syndrome, and in the worst case, death may be a serious complication [6].

Campylobacteriosis diagnostics

Due to the spreading of campylobacteriosis all over the world, routine diagnostics of *Campylobacter* spp. rods infections becomes increasingly important. Coccus and coccidal forms seem to be most problematic because of a very weak or no growth on a standard proliferating media [6]. Currently, culture and isolation of *Campylobacter* spp. are carried out by traditional cultures of the patient's blood and stool for the presence of the pathogen using standard differentiation media (chocolate agar, Campy-Blood Agar media, Thermo Scientific; TSB – Tryptone Soya Broth) or modern chromogenic media (CASA – Campylobacter Selective Agar, bioMérieux). In addition, there are commercially available biochemical tests for the rapid identification of microorganisms – the API Campy (bioMérieux) or the Dryspot Campylobacter Test Kit (Oxoid). Molecular biology techniques (such as RAPD, RFLP, AFLP, PFGE, Real-time PCR) and serological methods – ELISA and complement fixation CFX and two separate schemes: Lior's (based on heat-labile surface protein antigens) and Penner's (based on heat-stable antigens) can serve a *Campylobacter* spp. detection in a variety of materials, including food products [6,8,18]. A very significant development was the use of the multiplex-PCR in a combination with HPLC chromatography, which have a higher sensitivity (which is 8.8 x 102 CFU/ml for *C. jejuni*) and the identification of numerous pathogens in a different material in one reaction at the same time [19].

Treatment and *Campylobacter* spp. drug resistance problem

The etiology of infection with *Campylobacter* spp. is usually mild and self-limiting, and does not require antibiotic therapy. Campylobacteriosis treatment is then symptomatic and involves oral electrolytes completing. In case of a strong dehydration – intravenous hydration and excessive administration of drugs that inhibit peristalsis are recommended. Antibiotic therapy is prescribed in prolonged diarrhea and a large amount of blood in patients with severe fever, common symptoms, lasting for more than a week [5]. The first-line drugs are macrolide antibiotics, including erythromycin, azithromycin (oral, in the treatment of traveler's diarrhea especially), and fluoroquinolones – ciprofloxacin. More pointed, generalized form of the disease can be treated with other antibiotics, administered by intravenous infusion, such as for example cefotaxime and imipenem, but still after checking the microorganisms drug susceptibility [5].

Nowadays, we are witnessing an increasing genetic diversity, which promotes transmitting multiple factors of resistance to antimicrobial agents among bacteria, including *Campylobacter* spp. [20]. Drug resistance in this group of microorganisms already begins to emerge globally, to the extent that WHO considers it to be a serious social problem [21]. As in the case of many other organisms, it is mainly related with non-compliance or not following the rules of reasonable antimicrobial therapy, taking into consideration the pharmacokinetic and pharmacodynamic properties, including: the time of administration and the appropriate dose level (often the use of subthreshold/subtherapeutic dose) matched to the severity of the infection. It is also important that *C. jejuni* is able to use all three horizontal gene transfer mechanisms: natural transformation, conjugation and transduction [20].

Following the application of certain antibiotics by animal growth promoters in the animal breeding up to 2005, many bacteria – including *Campylobacter* spp. – acquired resistance to many of them. It is an immediate threat to human life, because there is a serious risk that the antibiotics (or their metabolites) administered to animals during breeding in minimal amount may reside in some food products (meat, milk, eggs). Close contact with animals or animal products could have a significant impact on antimicrobial resistance of opportunistic or pathogenic bacteria extending in humans [22].

Bacteria have developed one – (pointing to one group) and multidirectional resistance (aimed at several groups of antimicrobial agents) in response to most antibiotics and chemotherapeutics. Most of *Campylobacter* spp. strains are resistant to cephalothin and fluoroquinolones used in treatment of animals and humans, but sensitive to nalidixic acid [8,18]. Macrolides and tetracyclines are usually used with more difficult cases of infection with these bacteria. However, the increasing resistance of the *C. coli* and *C. jejuni* strains for fluoroquinolones, tetracyclines and erythromycin significantly affects the efficiency of antibiotic treatment [20]. Treatment of infection with *Campylobacter* spp. etiology is still based among macrolides on erythromycin and azythromycin [20,22]. The only alternative to fluoroquinolones and macrolides in a situation of generalized *Campylobacter* spp. infection is gentamicin, although some strains show a strong resistance to other aminoglycosides [23,24].

Determination of antimicrobial susceptibility of *Campylobacter* spp. in humans gives the doctors a possibility to use targeted antibiotic therapy against specific etiological infection factors. When the sensitivity was evaluated for over 250 strains of *Campylobacter* spp., researchers achieved nearly 50% of the *C. jejuni* and *C. coli* resistance to ciprofloxacin, 18% to tetracycline and 10% to ampicillin. As concerns a macrolide antibiotics group (erythromycin, gentamicin), it showed a strong sensitivity in almost all strains of *C. jejuni* and in all strains of *C. coli*. This may indicate the usefulness of this group of antimicrobials in the empirical treatment of campylobacteriosis [22]. The molecular analysis of resistance genes and mutations in the region of determining resistance to quinolones (QRDR) and the 23S RNA gene mutations in isolates of *Campylobacter* spp., has proven nearly 98% resistance to ciprofloxacin. Among 143 strains tested, 64% were characterized as tetracycline resistant, 9.1% and 6% were resistant to erythromycin and gentamycin, respectively. Moreover, multidrug resistance (MDR) was showed in 7% of the strains [25].

***Campylobacter* spp. infections prevention**

Due to the lack of vaccine against *Campylobacter* spp., a compliance with and understanding of the general safety instructions have the most important role in the prevention of infection with these bacteria, and an increasing number of campylobacteriosis cases. The American rule „from the farm to the fridge" becomes more crucial now. Proceeding and precautions rules should be implemented at the stage of animal breeding (poultry especially), preparing meat and products of animal origin products; they should also apply to persons remaining in close contact with them.

Bacterial infections caused by *Campylobacter* spp. are highly risky for the medical staff – doctors, nurses, laboratory diagnosticians and the remaining staff. Their main task is not only to diagnose accurately and rapidly or to treat adequately, but also to report any confirmed cases into the local sanitary-epidemiological stations and institutions involved in infectious disease epidemiology.

In turn, a counteraction of potential campylobacteriosis epidemics among consumers should be limited to the compliance with the basic hygiene rules in the first place – washing raw fruits and vegetables, adequate heat treatment of meat (temperature at least 70-80ºC), hands and utensils washed carefully (cutting boards, knives, dishes) after contact with raw animal origin food. Travelers, pregnant women and people with reduced immunity should take particular attention to these rules. It is recommended that they should drink treated clean water, avoid unpasteurized milk and poorly or undercooked meat [4,5].

Perspectives

The constant biotechnology development allows us to think about alternative ways of struggling with *Campylobacter* spp. such as: phage therapy (highly dependent on the phage type and the therapeutic dose effectiveness), the competitive exclusion of the use of products that reduce pathogens colonizing ability, bacteriocins produced by other bacteria (as OR-7 of *Lactobacillus salivarius*

and *Enterococcus*'s E-760). Designing a vaccine with surface protein subunits (flagellines or MOMPs – the major outer membrane proteins), PEB1 type adhesins (PEB1 permease proteins), or alternative secreted proteins against *Campylobacter* spp. would be an enormous achievement [20]. An access to genetic tools investigating the genomic sequences has greatly facilitated understanding of *Campylobacter* spp. as a cause of grievous zoonoses. Recent scientific advances have shown new capabilities of novel strategies for *Campylobacter* spp. prevention and colonization of divergent ecosystems and human infections control [20].

Campylobacteriosis in Europe

Until recently, the bacteria of the *Campylobacter* genus were called emerging pathogens [26]. For over 30 years, these microbes have been a major problem in the epidemiology of food poisoning and infections. Among so many important aspects of monitoring the presence of these microorganisms, their ubiquity is worth mentioning. Literature reports that *Campylobacter* spp. occurs in almost all countries around the world [6,27]. The reports of European Food Safety Authority (EFSA) and the European Centre for Disease Prevention and Control (ECDC) of zoonosis show that campylobacteriosis is one of the common, if not the most common, after salmonellosis and yersiniosis, zoonosis in the European Union [14,28,29].

The epidemiological data suggests that 335% of cases of food poisoning and infections is caused by thermo-tolerant *Campylobacter* species. In 70% etiologic factors of campylobacteriosis cases there are: *C. jejuni* subsp. *doylei*, *C. coli* and *C. jejuni* subsp. *jejuni*. Special attention should be given to the latter species, as the number of food poisoning and infections that this pathogen causes is often significantly higher than that caused by *Salmonella* spp. [14,27].

In Europe, there has been a disturbing trend that shows an increasing number of cases of campylobacteriosis in the period of 2006-2010, with a slight decrease in 2008, probably due to greater interest and increased supervision. According to epidemiological data, the number of laboratory-confirmed infections in humans and caused by bacteria of the *Campylobacter* genus in Europe amounted to a total of 212,064 cases, and 266 deaths due to campylobacteriosis people in 2010. The biggest number of infections and food poisoning was reported in the United Kingdom – 70,298 cases, which was just over 33% of all cases [14]. In 2010, the number of confirmed cases of campylobacteriosis in humans was higher than 6.7% compared with the previous year [17].

Worrying is also the fact that in the European Union there are reported more than 10,000 cases of campylobacteriosis every year – about 6 infections per 100,000 people in the population. Incidence rate of the disease in European countries amounted to an average of 48.56 per 100,000 population in 2010, with the highest recorded in the Czech Republic (200.58). However, in Greece, Portugal and Liechtenstein an adequate system of campylobacteriosis supervision and monitoring has not been developed yet [14].

Campylobacteriosis in Poland

Epidemiological reports of cases of infectious diseases, infections and poisoning are published by the National Institute of Public Health-National Institute of Health (NIPH-NIH) in Poland. This institution recorded the number of cases and the incidence of campylobacteriosis in the country over the years 2004-2011. In 2003, the list of *Campylobacter* spp. infections made by the NIPH-NIH Department of Epidemiology was incomplete, and the institute did not have accurate data from epidemiological studies monitoring the situation of campylobacteriosis in Poland before 1996 [30,31].

According to the EFSA and ECDC data, Poland takes the 24th place (367 recorded cases of infection – 0.17%) in the classification of the 31 European Union countries covered by the monitoring now. The next positions are taken by Latvia (with the least number of cases in Europe), Bulgaria, Cyprus, Iceland, Romania, Estonia and Malta [29].

A study done in the 1990s in Poland has shown that 68 (about 3%) were confirmed cases of 2443 cases of children with distinct complaints of the gastrointestinal tract; etiological agents are *C. jejuni* and *C. coli*, to a minor extent. On the other hand, in the years 1999-2000 similar cases have been reported in 11.1% children [17,27,32]. Recent reports from Poland published in 2012 for the period from January 2008 to December 2009, using an innovative method MAMA-PCR (mismatch amplification mutation assay) have showed that the *Campylobacter* spp. rods have been found to be in approximately 66% of the tested food samples (fresh raw poultry meat and poultry products) from large retail stores and smaller shops in the country. It also showed that the most commonly identified species of the *Campylobacter* genus in these foods was *C. coli* (75%) [25].

Based on reports from the Regional Sanitary-Epidemiological Station in our country, 1779 cases of campylobacteriosis were reported in 2004-2011 years (Table 1). The average number of cases was 222, and starting from 2004, it has been gradually increasing over the years. In the first year covered by the monitoring, 24 cases of campylobacteriosis were recorded. A sudden increase in incidence rate (up by 110 cases) occurred in 2005 and 2006. In subsequent years, the *Campylobacter* spp. infections became more widespread – the number of suffering people amounted to 192 in 2007 (representing 0.096% of all cases of campylobacteriosis etiology registered in the EU in a given year), and there were already 270 such cases in 2008. The next year brought

TABLE 1. The number of registered campylobacteriosis cases, the incidence rate and the number of people requiring hospitalization in Poland in 2004-2011 [own modification based on 30,31,33].

Years	Number of cases in quarters of a year				Number of cases in a year	Incidence per 100 000 population	Cases of people requiring hospitalization	
	I	II	III	IV			number	%
2004	2	6	10	6	24	0.06	19	79.2
2005	5	3	15	24	47	0.12	30	63.8
2006	20	28	41	68	157	0.41	88	56.1
2007	20	53	64	55	192	0.50	121	63.0
2008	26	59	95	90	270	0.71	153	56.7
2009	52	80	123	105	360	0.94	209	58.1
2010	64	93	117	101	375	0.98	203	54.1
2011	63	92	98	101	354	0.93	204	57.6
			Total		**1779**		**1027**	

the re-intensification of *Campylobacter* spp. infections by as much as 90 new patients. Latest NIH-PZH headlines provide a normalization of the campylobacteriosis epidemiological situation in Poland, as the number of cases in the years 2009-2011 was similar – in 2009 it was 360, while in 2010 and 2011 it reached the level of 375 and 354 of reported cases, respectively [30,31,33].

Because of symptoms of *Campylobacter* spp. infection, 1027 patients in Polish hospitals were reported in the period from 2004 to 2011. Most hospitalizations – 209 (just over 58% of all hospitalizations for this reason in a given year) were recorded in 2009, and then successively from 2010 to 2011 the number of admissions amounted to 203 (54%) and 204 (57.6%). A few people (only 19), were admitted to the hospital in 2004, but the proportion of patients requiring hospitalization was then the highest of all monitored years – equal to 79% (Table 1) [14,26,29,34].

Provinces with the first reported infection caused by this pathogen in 2004 were Małopolska and Mazovia Provinces (Table 2). With each passing year, more and more infections were recorded, exhibiting characteristics of campylobacteriosis – there were 1409 in 2004-2011. In the Lodzkie and Opolskie Voivodeships there were no cases of the disease as yet until 2011, and in Podlaskie Province there was one, in the Lublin Province – two infections. A few infections (less than 10) in relation to the whole country, were noted in the Świętokrzyskie and the Lower Silesia Provinces. The number of cases up to 10% in relation to all cases during the studied period concerned the Wielkopolska, Warmia-Masuria, Lubusz and the Małopolska Voivodeships. The overwhelming number of people who had infections caused by a *Campylobacter* spp. and symptoms of food poisoning, was recorded in Silesia Province – there were 693 people (49% of all cases) [30,33].

Campylobacteriosis incidence rate ranged from 0.06 in 2004, through 0.50 and 0.41 in 2006 and 2007, to 0.93-0.98 per 100,000 population in the period of 2009-2011 [29,30]. The latest NIPH-NIH data at the end of the third quarter of 2012 showed that the incidence was significantly higher compared with the same period and reached the value of 0.79 per 100,000 inhabitants, and on 15th December 2012, the incidence of campylobacteriosis exceeded the threshold of 1.00 [31].

NIPH-NIH also recently published a report containing information about the cases of campylobacteriosis in Poland in the period from 1st January to 15th December 2012 [31]. As the data confirm, 403 cases of this disease have been already diagnosed. By mid-year there were 171 – the highest value in comparison with the previous seven years, and only in October 50 new cases of food poisoning and infections of the same ground have been reported. In comparison, in the same period of the previous year, 319 people infected with *Campylobacter* spp. rods were registered [31].

Given the number of cases for each quarter of the year, a regularity becomes noticeable – we can observe an increased incidence of bacterial intestinal infections in the summer (June-August) compared to other periods of the calendar year. This was also proved in EFSA and ECDC reports. In the first two quarters of the monitored years in Poland, the number of cases was at the lowest level – reported an average of about 32 cases, their number increased on average from nearly 52 in the second, and 70 in the third and fourth quarter (Table 1) [29-31,33]. According to the preliminary NIPH-NIH data, it can be concluded that the third quarter of 2012 was characterized by the highest ever number of cases of campylobacteriosis in comparison with previous years [31].

TABLE 2. Number of cases by provinces in Poland in 2004-2011 [own modification based on 30,33].

No.	Voivodeship	2004	2005	2006	2007	2008	2009	2010/2011	Number of cases in 2004 – 2011
1.	Lower Silesia	-	-	3	-	5	-	-	8
2.	Kujawy-Pomerania	-	-	-	-	1	2	12	15
3.	Lubelskie	-	-	-	-	-	1	1	2
4.	Lubusz	-	3	26	28	21	47	27	152
5.	Lodzkie	-	-	-	-	-	-	-	-
6.	Małopolska	22	4	22	18	15	36	37	154
7.	Mazovia	2	1	7	6	10	17	33	76
8.	Opole	-	-	-	-	-	-	-	-
9.	Podkarpacie	-	-	6	1	-	-	4	11
10.	Podlaskie	-	-	-	-	-	-	1	1
11.	Pomerania	-	-	-	3	4	2	1	10
12.	Silesia	-	39	86	116	169	171	112	693
13.	Świętokrzyskie	-	-	-	2	3	-	-	5
14.	Warmia-Masuria	-	-	7		19	-	104	135
15.	Wielkopolska	-	-	-	18	23	39	21	101
16.	Zachodniopomorskie	-	-	-	-	-	45	1	46
								Total	**1409**

CONCLUSIONS

Despite the widespread publicity of campylobacteriosis in the world, many countries have not developed any effective monitoring of the epidemiological status of the disease yet. Surveillance programs in animals and food should identify any of the risks and potential sources and transmission gates of *Campylobacter* spp. on people. It is recommended that any pediatric fecal sample should be examined for the presence of both *Salmonella* spp., *Shigella* spp. and *Campylobacter* spp. too. This strategy should be implemented for all patients with symptoms of diarrhea.

Epidemiological data clearly suggest the significance of the campylobacteriosis problem in Poland. It takes higher and higher positions in the general classification of infectious diseases in our country. Therefore, EFSA puts a strong emphasis on the importance of campylobacteriosis in all European countries and recommended the implementation of an active surveillance of cases of the disease, and turn attention to the collection and genotyping of any *Campylobacter* spp. isolates. The British government has planned for this reason so called „innovative strategy for Campylobacter in the food chain" because of the highest incidence rates and incidence of campylobacteriosis in Europe in 2010-2015 [14,17,19,26,28,29,35].

REFERENCES

1. Adamek J. Zatrucia pokarmowe. Przew Lek. 2002;5(3):117-20.
2. Górska S, Jarząb A, Gamian A. Bakterie probiotyczne w przewodzie pokarmowym człowieka jako czynnik stymulujący układ odpornościowy. Post Hig Med Dośw. 2009;63:653-67.
3. Jarząb A, Górska-Frączek S, Rybka J, Witkowska D. Zakażenia pałeczkami jelitowymi – diagnostyka, oporność na antybiotyki i profilaktyka. Post Hig Med Dośw. 2011;65:55-72.
4. Samie A, Obi CL, Barrett LJ, et al. Prevalence of *Campylobacter* species, *Helicobacter pylori* and *Arcobacter* species in stool samples from the Venda region, Limpopo, South Africa: Studies using molecular diagnostic methods. J Infect. 2007;54:558-66.
5. Adedayo O, Kirkpatrick BD. *Campylobacter jejuni* infections: update on presentation, diagnosis, and management. Hosp Physician. 2008;44:9-15.
6. Daczkowska-Kozon E. Co wiemy i czego nie wiemy o *Campylobacter* spp.? Post Mikrobiol. 2002;41(1):85-104.
7. Garénaux A, Jugiau F, Rama F, et al. Survival of *Campylobacter jejuni* strains from different origins under oxidative stress conditions: effect of temperature. Curr Microbiol. 2008;56(4):293-7.
8. Silva J, Leite D, Fernandes M, et al. *Campylobacter* spp. as a foodborne pathogen: a review. Front Microbiol. 2011;2:200
9. Ge Z, Schauer DB, Fox JG. In vivo virulence properties of bacterial cytolethal-distending toxin. Cell Microbiol. 2008;10(8):1599-607.
10. Jagusztyn–Krynicka EK, Wyszyńska A, Łasica AM. Oddziaływanie *Campylobacter jejuni* z komórkami eukariotycznymi – komensalizm a chorobotwórczość. Post Mikrobiol. 2006;45(1):11-7.
11. Jin S, Joe A, Lynett J, et al. JlpA, a novel surface-exposed lipoprotein specific to *Campylobacter jejuni*, mediates adherence to host epithelial cells. Mol Microbiol. 2001;39(5):1225-36.
12. Lara-Tejero M, Galán JE. CdtA, CdtB and CdtC form a tripartite complex that is required for cytolethal distending toxin activity. Infect Immun. 2001;69(7):4358-65.
13. Van Deun K, Haesebrouck F, Heyndrickx M, et al. Virulence properties of *Campylobacter jejuni* isolates of poultry and human origin. J Med Microbiol. 2007;56:1284-9.
14. The community summary report on trends and sources of zoonoses, zoonotic agents and foodborne outbreaks in the European Union in 2010. EFSA J. 2012;10(3):2597.
15. Kumar A, Agarwal RK, Bhilegaonkar KN, et al. Occurence of *Campylobacter jejuni* in vegetables. Int J Food Microbiol. 2001;67:153-5.
16. Kwiatek K, Wojton B, Stern NJ. Prevalence and distribution of *Campylobacter* spp. on poultry and selected red meat carcasses in Poland. J Food Protect. 1990;53(2):127-30.
17. Kwiatek K, Zasadny R, Wojdat E. Występowanie termotolerancyjnych drobnoustrojów z rodzaju *Campylobacter* na powierzchni tusz zwierząt rzeźnych. Przegl Epidemiol. 2006;60:347-52.
18. Mikucki J, Szewczyk EM. Mikrobiologia szczegółowa i diagnostyka mikrobiologiczna: skrypt dla studentów Oddziału Medycyny Laboratoryjnej. Łódź: Akademia Medyczna; 2001.
19. Xu Y, Cui L, Tan Ch, et al. A multiplex polymerase chain reaction coupled with high-perfomance liquid chromatography assay for simultaneous detection of six foodborne pathogens. Food Control. 2012;25(2):778-83.
20. Jeon B, Muraoka WT, Zhang Q. Advances in *Campylobacter* biology and implications for biotechnological applications. Microbial Biotech. 2010;3(3):242-58.
21. Department of communicable Disease Surveillance and Response World Health Organization the increasing incidence of human campylobacteriosis report and proceedings of a WHO consultation of experts. Denmark; 2000. (http://whqlibdoc.who.int/hq/2001/who_cds_csr_aph_2001.7.pdf).
22. Rożynek E, Dzierżanowska-Fangrat K, Szczepańska B, et al. Trends in antimicrobial susceptibility of *Campylobacter* isolates in Poland (2000-2007). Polish J Microbiol. 2009;58(2):111-5.
23. Aarestrup FM, Engberg J. Antimicrobial resistance of thermophilic *Campylobacter*. Vet Res. 2001;32(3-4):311-21.
24. Krutkiewicz A, Klimuszko D. Mechanizmy oporności pałeczek *Campylobacter* sp. na chemioterapeutyki. Post Mikrobiol. 2008;47(4):489-95.
25. Maćkiw E, Korsak D, Rzewuska K, et al. Antibiotic resistance in *Campylobacter jejuni* and *Campylobacter coli* isolated from food in Poland. Food Control. 2012;23:297-301.
26. Wassenaar TM, Blaser MJ. Pathophysiology of *Campylobacter jejuni* infections of humans. Microbes and Infect. 1999;1(12):1023-33.
27. Żurawska-Olszewska J, Krzesłowska I, Długosz G, Krasiukianis A. Etiology of acute diarrheas in children from the Lodz region. Occurrence of etiologic agents. Med Dosw Mikrobiol. 2002;54(2):129-36.
28. Park SF. The physiology of *Campylobacter* species and its relevance to their role as foodborne pathogens. Int J Food Microbiol. 2002;74(3):177-88.
29. The community summary report on trends and sources of zoonoses and zoonoti agents in the European Union in 2007. EFSA J. 2009;223:223-440.
30. Czarkowski MP, Cielebąk E, Kondej B, Staszewska E. Choroby zakaźne i zatrucia w Polsce. Warszawa: NIZP-PZH – Zakład Epidemiologii. Roczniki 2004–2009. (http://www.pzh.gov.pl/oldpage/epimeld/2012/index_mp.html).
31. Meldunki o zachorowaniach na choroby zakaźne, zakażeniach i zatruciach w Polsce. NIZP-PZH – Zakład Epidemiologii. (http://www.pzh.gov.pl/oldpage/epimeld/index_p.html).
32. Gościniak G, Przondo-Mordarska A, Stankiewicz M, Mauff G. Zakażenia *Campylobacter jejuni* wśród hospitalizowanych chorych. Wiad Lek. 1991;44(7-8):259-62.
33. Sadkowska-Todys M. Kampylobakterioza w Polsce w 2007 roku. Przegl Epidemiol. 2009;63:225-7.
34. Stojanov IM, Velhner MJ, Orlić DB. Presence of *Campylobacter* spp. in nature. Proc Nat Sci. 2004;107:75-83.
35. UK Research and innovation strategy for *Campylobacter* – in the food chain 2010-2015. (http://www.food.gov.uk/multimedia/pdfs/campylobacterstrategy.pdf).

Informacja o Autorkach

Mgr inż. Sylwia Nowicka – asystent; mgr farm. Magdalena Zdziebło – doktorantka; mgr Kinga Skrzypek – doktorantka; dr n. farm. Urszula Kosikowska – adiunkt; prof. dr hab. n. farm. Anna Malm – kierownik. Katedra i Zakład Mikrobiologii Farmaceutycznej z Pracownią Diagnostyki Mikrobiologicznej, Uniwersytet Medyczny w Lublinie.

Adres do korespondencji

Sylwia Nowicka
ul. Chodźki 1, 20-093 Lublin
Tel: (81) 742 37 30
E-mail: s.nowicka@umlub.pl