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ORIGINAL ARTICLE / ОРИГИНАЛНИ РАД

Pertussis incidence rates in Novi Sad (Serbia) before and during improved surveillance

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SUMMARY

Introduction/Objective The Global Pertussis Initiative (GPI) proposed clinical case definitions for pertussis diagnosis in three different age cohorts in order to improve surveillance of pertussis especially in older children, adolescents, and adults.

The main goal of this research was to compare the burden of pertussis in the city of Novi Sad before and after the introduction of improved surveillance using the GPI clinical case definitions of pertussis.

Methods Baseline data on pertussis were obtained from routine (non-sentinel) reporting before improved surveillance was introduced. From September 16, 2012, clinical case definitions proposed by GPI were applied within improved (sentinel and hospital) surveillance, while surveillance clinical case definitions were not introduced within non-sentinel. To confirm the suspected diagnosis, sampling of nasopharyngeal swab and/or blood was obtained from all cases. The choice of laboratory method (PCR or ELISA) depended on the duration of coughing and the age of the patients. Data were statistically processed by SPSS Statistics, version 22.

Results During the 12-year period before the introduction of improved surveillance, only two clinical pertussis cases were registered. In contrast, during the two-year period of improved surveillance, a total of 14 (season 2012/13) and 146 (season 2013/2014) confirmed pertussis cases were reported. Significant differences were determined in distribution of pertussis according to the type of surveillance and the level of health care.

Conclusion Introduction of clinical case definitions proposed by GPI improved the quality of surveillance and enabled an insight in the distribution of pertussis in all age groups and at all levels of health care.

Keywords: pertussis; surveillance; epidemiology

INTRODUCTION

Before vaccines became widely available, pertussis was one of the most common childhood diseases worldwide. Following large-scale vaccination during the 1950s and 1960s, a dramatic reduction (> 90%) in incidence and mortality of pertussis was observed in the industrialized world. Estimates from WHO suggest that in 2008 about 16 million cases of pertussis occurred worldwide, 95% of which were in developing countries, and that about 195,000 children died from this disease [1]. In developed countries, pertussis is increasingly reported in older children, adolescents and adults [2]. The true burden of pertussis is unknown and is still significantly underestimated.

Today, many different case definitions are used throughout the world. Most case definitions are supplemented with laboratory and epidemiological data so that reports may be categorized as confirmed, probable, or suspect. The Global Pertussis Initiative (GPI) described the difficulties in defining pertussis from a clinical perspective. In recognition to the fact that the signs and symptoms of pertussis differ by age, GPI has tailored criteria for pertussis diagnosis in three age cohorts (0–3 months, four months to nine years, and ≥ 10 years) [3].

Unlike in many other European countries, quality of surveillance in Serbia has not influenced the immunization strategy against pertussis. Immunization against pertussis in Serbia is mandatory according to the Law on Protection of Population Against Communicable Diseases. The primary series comprises three doses of DTP (combined diphtheria-tetanus-whole cell pertussis) or DTaP (combined diphtheria-tetanus-acellular pertussis) vaccine given at two months of life with an interval of four weeks between subsequent doses. Currently, only booster against pertussis is given during the second year of life, one year after the third dose in the primary series. Immunization coverage with primary series and revaccination in the Autonomous Province of Vojvodina (APV) is over 95% [4].

In 2012, in addition to mandatory routine, non-sentinel surveillance, improved surveillance of pertussis was implemented and funded in the APV, as a part of Special Public Health Program. It included hospital surveillance (all

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hospitals in the province) and sentinel surveillance (city of Novi Sad). This paper reports on the results of improved surveillance and routine surveillance (non-sentinel) conducted in the city of Novi Sad.

The main goal of this study is to compare the burden of pertussis before and after the introduction of improved surveillance of pertussis and to determine differences in registered overall and age-specific incidence rates between the improved and routine, non-sentinel surveillance of pertussis.

METHODS

The research was carried out by the Institute of Public Health of Vojvodina in Novi Sad, the main administrative center of the APV in northern Serbia. According to the 2011 census there are 341,624 people living in Novi Sad**.** Data relevant to the study were collected in collaboration with the primary, secondary, and tertiary healthcare facilities.

Determination of the burden of pertussis before the introduction of improved surveillance

In order to investigate the burden of pertussis in the period from January 1, 2001 to September 15, 2012, reports from the routine, non-sentinel reporting system were obtained. The source of data for routine, non-sentinel surveillance was mandatory notification of pertussis, as reported to the Institute of Public Health of Vojvodina in accordance with the Law on Protection of Population from Infectious Diseases [5]. The Law mandates reporting of communicable diseases and does not determine diagnostic criteria or clinical case definitions.

Determination of the burden of pertussis after the introduction of improved surveillance

The research was carried out in two periods: the first one in the 2012/13 season – from September 16, 2012 until September 15, 2013, and the second one in the season of 2013/14 – from September 16, 2013 until September 15, 2014. During these two seasons, in addition to the routine non-sentinel surveillance, sentinel surveillance was carried out at the primary healthcare level in the city of Novi Sad. At secondary and tertiary healthcare level, hospital surveillance was improved in the entire province. Within the sentinel and hospital surveillance, clinical case definitions proposed by GPI were used, while within the routine surveillance the only criteria for reporting was clinical diagnosis based on the opinion of the physician examining the patient. A subset of hospitalized patients, only those from Novi Sad, was analyzed in this paper.

Description of components in improved surveillance in the city of Novi Sad

Sentinel surveillance

Sentinel surveillance was carried out through an existing network of sentinel physicians in Novi Sad Health Centre (10 general practitioners and five pediatricians) who treat patients with developed cough and other symptoms and signs corresponding to the GPI clinical case definition of the disease. Population under sentinel surveillance included patients cared for by sentinel physicians, 22,830 patients during the 2012/13 season (6.7% of the total population of the city of Novi Sad) and 22,385 patients during 2013/14 season (6.6% of the population). Sentinel surveillance population was stratified for data analysis by age groups: 0–12 months of age, 1–6 years, 7–19 years, and 20 years or older (Table 1).

Hospital surveillance

Hospital surveillance was carried out in cooperation with stationary healthcare facilities where patients from Novi Sad were hospitalized with cough and other symptoms and signs that correspond to the GPI clinical case definition of pertussis.

Epidemiological investigation of close contacts

Epidemiological investigation of close contacts was conducted in accordance with the Law on Protection of Population from Infectious Diseases in the Republic of Serbia. The collection of epidemiological and clinical data was conducted by the epidemiologist of the Institute of Public Health in collaboration with the patient's primary care physician.

Close contacts of confirmed pertussis cases (family, other groups) were checked for prolonged cough (more than two weeks), without increased temperature or with minimally increased temperature. Biological samples were

Table 1. Population under sentinel and routine, non-sentinel surveillance according to age groups

Age group	Population of Novi Sad according to 2011 Census	Population under routine non-sentinel surveillance in 2012/13 season	Population (%) under sentinel surveillance in 2012/13 season	Population under routine non-sentinel surveillance in 2013/14 season	Population (%) under sentinel surveillance in 2013/14 season
	n	n	n (%)	n	n (%)
0–12 months	3,673	3,233 (88.0)	440 (12.0)	3,235 (88.1)	438 (11.9)
1–6 years	21,580	18,519 (85.8)	3,061 (14.2)	18,444 (85.5)	3,136 (14.5)
7–19 years	44,519	42,194 (94.8)	2,325 (5.2)	41,384 (93.0)	3,135 (7.0)
20+ years	271,852	254,848 (93.7)	17,004 (6.3)	256,176 (94.2)	15,676 (5.8)
Total	341,624	318,794 (93.3)	22,830 (6.7)	319,239 (93.4)	22,385 (6.6)

obtained from close contacts in order to confirm the diagnosis of the disease. Laboratory analyses were conducted regardless of whether the symptoms fitted the clinical case definition. Contacts, including the ones that were established through hospital surveillance, were further classified on sentinel and non-sentinel contacts dependent whether primary patient was cared for by sentinel or non-sentinel physician. Classification of contacts was done so that the more accurate rates could have been calculated in sentinel and non-sentinel population.

Target group

Target group of the research were all patients from sentinel and hospital surveillance with symptoms and signs of clinical disease that fulfilled the GPI clinical case definition of pertussis, as well as patients detected in routine surveillance based on clinical diagnosis set by the physician.

Pertussis case definition

In accordance with the recommendations of the GPI, the clinical case definitions of pertussis presented in Figure 1 were implemented [3].

Sampling and transport of patient material

To confirm the suspected diagnosis, sampling of nasopharyngeal swab (NPS) for polymerase chain reaction (PCR) and/or blood (pertussis serology) was obtained from all cases.

Sampling was conducted by sentinel physician at the Health Centre or by trained laboratory staff of the Institute of Public Health. In case the patient was hospitalized, blood and NPS specimens were obtained by the health facilities competent staff.

Before transport to the Institute of Public Health of Vojvodina, all samples were stored in a refrigerator at the point of sampling, and transported in a hand refrigerator within 48 hours after sampling.

Laboratory testing of samples and interpretation of results

Sample testing was carried out at the Institute of Public Health of Vojvodina. The choice of laboratory method depended on the duration of coughing and the age of the patients included in the survey:

1. For patients of all ages in whom the onset of cough was less than three weeks prior to the testing, and for those up to three months of age, regardless of the duration of cough, the testing of NPS was performed by PCR. The following commercial kits were used: Bordetella R-gene™ (ARGENE, BioMerieux, Marcy-l'Étoile, France) and *Bordetella pertussis* / *B. parapertussis* / *B. bronchiseptica* Real-TM (Sacace Biotecnologies Srl., Como, Italy).

2. Among patients aged four months and older, with a duration of cough of more than three weeks, and where the application of the last dose of DTP/DTaP vaccine had been more than 12 months ago, testing of the serum samples was done by using the following commercial kits: Anti-Bordetella pertussis toxin ELISA (IgG) with four calibrators 5 IU/ml, 25 IU/ml, 100 IU/ml, and 200 IU/ml; Anti-Bordetella pertussis toxin ELISA (IgA) with four calibrators 2 IU/ml, 10 IU/ml, 25 IU/ml, and 50 IU/ml (Euroimmun, Lübeck, Germany). If anti-PT IgG was 40, according to manufacturer's instructions the result did not indicate acute infection. If anti-PT IgG was ≥ 100, the result indicated acute infection. If anti-PT IgG was between 40 and 100 IU/ml, detection of anti-PT IgA was performed. If anti-PT IgA exceeded the age-dependent reference range, the result indicated positive result and acute infection. If anti-PT IgA was below the-age dependent reference range, the result did not indicate acute infection.

3. Among persons aged four months and older in whom the occurrence with a duration of cough of more than three weeks, and where the last dose of DTP/DTaP vaccine was administered less than one year ago, the testing of the samples to pertussis was done by using the same commercial kits as mentioned above. Additionally, in case the findings in these patients were inconclusive, secondary

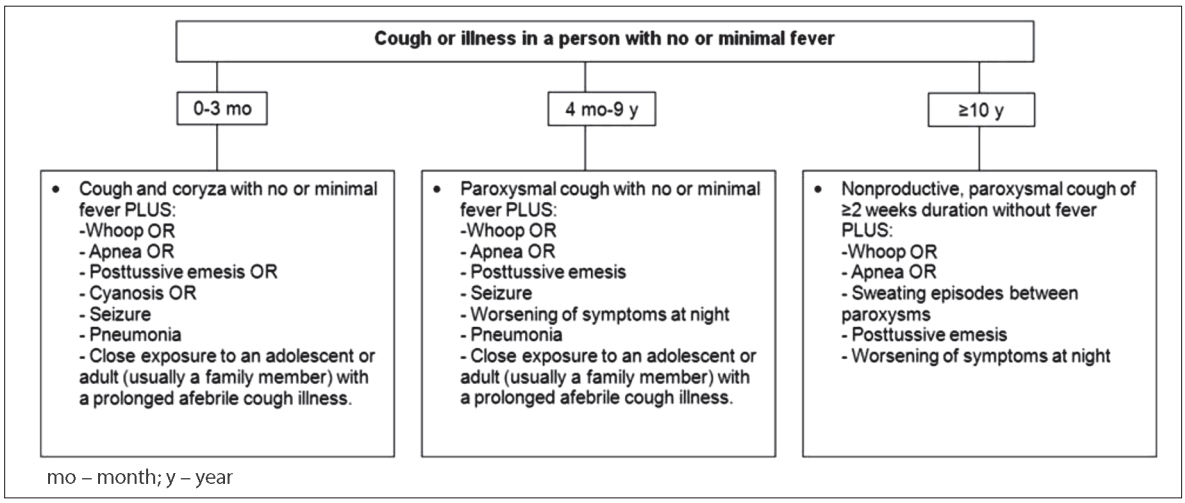

Figure 1. Implemented clinical case definitions of pertussis in accordance with the recommendations of the GPI [3]

Table 2. Suspect and confirmed pertussis cases according to the type of surveillance in both seasons

Type of surveillance	Season 2012/13 Sept. 16, 2012 – Sept. 15, 2013		Season 2013/14 Sept. 16, 2013 – Sept. 15, 2014	
	Number of suspected cases	Number (%) of confirmed cases	Number of suspected cases	Number (%) of confirmed cases
Sentinel	34	3 (8.8)	208	47 (22.6)
Close contacts	9	4 (44.4)	15	8 (53.3)
Subtotal	43	7 (16.3)	223	55 (24.7)
Hospital	25	4 (16.0)	100	53 (53.0)
Close contacts	6	3 (50.0)	8	3 (37.5)
Subtotal	31	7 (22.6)	108	56 (51.6)
Non-sentinel	0	0 (-)	61	26 (42.6)
Close contacts	0	0 (-)	22	9 (40.9)
Subtotal	0	0 (-)	83	35 (42.2)
Total	74	14 (18.9)	414	146 (35.3)

cases were investigated and laboratory-confirmed in order to establish epidemiological link with the inconclusive case so that the true number of pertussis cases (including vaccine failures) could have been ascertained and the true epidemiology of the disease established.

A confirmed case of pertussis was every suspected case with laboratory confirmation of pertussis. Suspected cases of pertussis with negative laboratory results were not classified as pertussis and further clinical and laboratory follow-up was conducted towards determination of true etiology of the disease. Laboratory findings were reported back to the caring physicians.

Data processing and analysis of the survey results

The obtained data were statistically processed using SPSS Statistics for Windows, Version 22.0 (IBM Corp., Armonk, NY, USA). The results are presented as a frequency, pertussis incidence (per 100,000 persons) with 95% confidence interval (Wilson score). The difference among registered number of confirmed pertussis cases was tested by the χ^2 test. Two-tailed p-values < 0.05 were considered to be significant.

Nominators were the numbers of confirmed pertussis cases in total sentinel population and in the age groups, and respective numbers in non-sentinel population under routine surveillance. Denominators for calculation of rates were as follows: the total population monitored by the sentinel surveillance in a given season and population of Novi Sad according to 2011 census subtracted for the number of people monitored through the sentinel surveillance (Table 1).

RESULTS

Burden of pertussis before the introduction of improved surveillance

In the period from 2001 to September 15, 2012 in the city of Novi Sad, only two pertussis cases were reported. The diagnosis was based exclusively on clinical grounds. Both cases were unvaccinated children four months of age who required hospitalization.

Burden of pertussis after the introduction of improved surveillance

A total of 14 and 146 pertussis cases were confirmed during the 2012/13 and 2013/14 seasons, respectively. During the first season (2012/13) of improved surveillance based on GPI clinical case definition, a total of 34 and 25 suspected cases within sentinel and hospital surveillance were reported, respectively. Laboratory confirmation of pertussis was obtained for three and four cases in sentinel and hospital surveillance, respectively. Highest percentage of confirmed cases after epidemiological investigation was determined among close contacts of confirmed pertussis cases with four and three cases determined among close contacts of confirmed cases in sentinel and hospital surveillance (Table 2). During the same period of observation there were no suspected cases registered in the routine, non-sentinel surveillance.

During the 2013/14 season, out of 61 suspected cases indicated in the non-sentinel surveillance, pertussis was confirmed in 26 (42.6%). During the same period, there were 47 (22.6%) and 53 (53%) confirmed cases registered out of 208 and 100 suspected cases in sentinel and hospital surveillance, respectively. Among the close contacts, out of 45 suspected cases, there were 20 confirmed cases registered, with eight (53.3%), three (37.5%), and nine (40.9%) originating from confirmed cases detected through the sentinel, hospital, and non-sentinel surveillance, respectively.

In the 2012/13 season, one half of confirmed cases was determined through epidemiological investigation of close contacts with one being a member of sentinel and six members of non-sentinel population. Among laboratory confirmed cases, three were detected through sentinel surveillance in primary health care, while the remaining four were registered in hospitals and were members of non-sentinel population. All four pertussis cases from non-sentinel population were missed in routine surveillance because all of them were sent to hospitals under other diagnosis (Table 3).

In the 2013/14 season, 73 (50%) of all confirmed cases were detected by primary health care level physicians through sentinel or non-sentinel, routine surveillance. Sig-

Table 3. Distribution of confirmed pertussis cases from sentinel and non-sentinel population according to the type of surveillance and level of health care during the period of improved surveillance

Season	Type of surveillance and level of health care	Total n (%)	Incidence per 100,000 population	Sentinel n (%)	Incidence per 100,000 population	χ^2 p-value	Non-sentinel n (%)	Incidence per 100,000 population	χ^2 p-value
2012/13	Primary level	3 (21.4)	0.9	3 (75)	13.1		0 (0)	0	
	Hospital	4 (28.6)	1.2	0 (0)	0		4 (40)	1.3	
	Epidemiological investigation of close contacts – field investigation	7 (50)	2	1 (25)	4.4	*	6 (60)	1.9	*
	Overall	14 (100)	**4.1**	4 (100)	**17.5**		10 (100)	**3.1**	
	No. of people under surveillance	**341,625**		**22,830**			**318,795**		
2013/14	Primary level	73 (50)	21.4	47 (87)	210	$\chi^2 = 29.438$ $p < 0.001$	26 (28.3)	8.1	$\chi^2 = 22.196$ $p < 0.001$
	Hospital	53 (36.3)	15.5	2 (3.7)	8.9		51 (55.4)	16	
	Epidemiological investigation of close contacts – field investigation	20 (13.7)	5.9	5 (9.3)	22.3		15 (16.3)	4.7	
	Overall	146 (100)	**42.7**	54 (100)	**241.2**		92 (100)	**28.8**	
	No. of people under surveillance	**341,625**		**22,385**			**319,240**		

* It was not possible to calculate the probability due to small size of the sample

nificant differences in distribution of confirmed pertussis cases from sentinel and non-sentinel population according to the type of surveillance and level of health care were determined. Sentinel physicians detected confirmed cases more frequently than non-sentinel physicians.

In 36.3% of all cases, suspect cases were detected according to the GPI clinical case definition in hospitals. Primary health care level physician did not suspect pertussis in these cases. Patients were sent to hospitals under diagnoses other than pertussis. Among hospitalized patients, only two (3.7%) out of 54 cases from the sentinel population were unrecognized by sentinel physicians. The majority of 51 (55.4%) out of 92 cases from of non-sentinel population were confirmed during hospitalization.

Patients with confirmed pertussis after epidemiological investigation of close contacts make up 13.7% of the overall number of confirmed cases in 2013/14 season. They did not seek medical attention from their primary health care level physician.

Dependent on the type of surveillance and clinical case definition used, significant differences in age-specific incidence and burden of the disease in the population of Novi Sad were registered when compared between sentinel and routine surveillance during the season of 2013/14 (Table 4).

Pertussis was reported in all age groups through sentinel surveillance. The highest age-specific incidence rates were noted in school-age children and adolescents (988.8/100,000). A high age-specific incidence rate was also found in unimmunized or incompletely immunized children of the youngest age group (newborns and infants), 456.6/100,000. The lowest age-specific incidence rate was registered in adults (38.3/100,000).

Through non-sentinel, routine surveillance, pertussis was not registered in the youngest age group and in adults. Registered age-specific incidence rates in children 1–6 years of age (16.3/100,000) and in children 7–19 years of age (55.6/100,000) were several times lower than those registered through sentinel and hospital surveillance in respective age groups.

Age distribution of patients registered in hospitals confirms the presence of pertussis in all age groups. The highest age-specific incidence in hospitalized patients was registered in the youngest age group (136.1/100,000). Distribution of confirmed cases from sentinel and non-sentinel population detected in hospitals was statistically significant in the youngest age group.

Among 20 cases registered in close contacts of confirmed cases, there were no confirmed cases in the youngest age group, while 12 were adults. Distribution of confirmed cases among close contacts from sentinel and non-sentinel population was highly statistically significant in age groups of 1–6 and 7–19 years.

DISCUSSION

Comparative analyses of results shows that registered burden of pertussis and distribution of cases in population depend on the type of surveillance and applied clinical case definition. Sentinel surveillance showed that all age groups were affected and that pertussis is widely distributed in our population. Detection of pertussis in the first season of improved surveillance in hospitals and through sentinel network of physicians most probably contributed to the registration of the disease within non-sentinel, routine surveillance at primary healthcare level during the second season of improved surveillance. Epidemiological investigation of close contacts of confirmed cases showed that adults represent reservoir of the infection for younger age groups and for the sustainable transmission of disease in the whole population. Clinical case definitions proposed by the GPI seem more adequate in recognition of severe forms of the disease.

Table 4. Incidence and age-specific incidence of pertussis in sentinel and non-sentinel population in the 2013/14 season

Age group	Type of surveillance and origin of population	Population	Confirmed cases	Incidence per 100,000			χ^2 p-value
			n	Value	95% CI lower limit	95% CI upper limit	
0–12 months	Sentinel	438	2	456.6	125.3	1,649.4	$\chi^2 = 14.78$ $p < 0.001$
	Non-sentinel	3,235	0	0			
	Total	**3,673**	2	54.5	14.9	198.3	
	Hospital – sentinel	438	0	0			$\chi^2 = 14.78$ $p < 0.001$
	Hospital – non-sentinel	3,235	5	154.6	66	361.3	
	Total	**3,673**	5	136.1	58.2	318.3	
	Contacts – sentinel	438	**0**	0	-	-	-
	Contacts – non-sentinel	3,235	**0**	0	-	-	
	Total	**3,673**	**0**	0	-	-	
	Overall	3,673	7	190.6	92.3	392.9	
1–6 years	Sentinel	3136	8	255.1	129.3	502.6	$\chi^2 = 30.01$ $p < 0.001$
	Non-sentinel	18,444	3	16.3	5.5	47.8	
	Total	**21,580**	11	51	28.5	91.3	
	Hospital – sentinel	3,136	0	0			$p = 0.41$
	Hospital – non-sentinel	18,444	4	21.7	8.4	55.8	
	Total	**21,580**	4	18.5	7.2	47.7	
	Contacts – sentinel	3,136	2	63.8	17.5	232.2	$\chi^2 = 6.566$ $p = 0.01$
	Contacts – non-sentinel	18,444	1	5.4	1	30.7	
	Total	**21,580**	3	13.9	4.7	40.9	
	Overall	**21,580**	**18**	**83.4**	**52.8**	**131.8**	
7–19 years	Sentinel	3,135	31	988.8	697.5	1,400.1	$\chi^2 = 209.511$ $p < 0.001$
	Non-sentinel	41,384	23	55.6	37	83.4	
	Total	**44,519**	54	121.3	93	158.2	
	Hospital – sentinel	3,135	0	0			$p = 0.108$
	Hospital – non-sentinel	41,384	34	82.2	58.8	114.8	
	Total	**44,519**	34	76.4	54.7	106.7	
	Contacts – sentinel	3,135	2	63.8	17.5	232.3	$\chi^2 = 8.298$ $p = 0.004$
	Contacts – non-sentinel	41,384	3	7.2	2.5	21.3	
	Total	**44,519**	5	11.2	4.8	26.3	
	Overall	**44,519**	**93**	**208.9**	**170.6**	**255.8**	
20+ years	Sentinel	15,676	6	38.3	17.5	83.5	$\chi^2 = 98.054$ $p < 0.001$
	Non-sentinel	25,6177	0	0			
	Total	**271,853**	6	2.2	1	4.8	
	Hospital – sentinel	15,676	2	12.8	3.5	46.5	$\chi^2 = 3.729$ $p = 0.053$
	Hospital – non-sentinel	256,177	8	3.1	1.6	6.2	
	Total	**271,853**	10	3.7	2	6.8	
	Contacts – sentinel	15,676	1	6.4	1.1	36.1	$p = 0.702$
	Contacts – non-sentinel	256,177	11	4.3	2.4	7.7	
	Total	**271,853**	12	4.4	2.5	7.7	
	Overall	**271,853**	**28**	**10.3**	**7.1**	**14.9**	

Epidemiological situation of pertussis in Novi Sad was not known well until 2012, though the change in epidemiological characteristics of pertussis occurred in countries with high vaccination coverage [2]. Due to the lack of laboratory diagnostics and consequently insufficient reporting, in the period before the improved surveillance, the disease was registered discontinuously as sporadic cases without laboratory confirmation. Therefore, the change of epidemiological characteristics of pertussis was not registered in our country, unlike the shift towards an increase in pertussis incidence to older age groups in some other countries [6]. Within sentinel surveillance, where indication for laboratory analyses was determined in line with GPI clinical case definition, confirmed cases were detected in both seasons (2012/13 and 2013/14). During the first season of improved surveillance (2012/13), non-sentinel physicians did not detect any suspect cases of pertussis, just like in the period before the improved surveillance. Therefore, none of the cases were confirmed through routine surveillance. Although the incidence registered through sentinel surveillance in the sample of population cannot be compared to the true incidence but only esti-

mated, disease distribution and rates are similar to those registered in other European countries [7]. All hospitalized cases initially referred to the hospital under clinical diagnosis of prolonged cough without initial suspicion of pertussis were considered unrecognized or missed at the primary healthcare level. A total of 55 out of 57 pertussis cases registered in a hospital setting were missed by non-sentinel physicians and only two cases were considered missed in the sentinel surveillance in 2013/14 season because the final diagnosis was set in the hospital.

Highest age-specific incidence rates were detected in school-age children and adolescents in 2013/14 season. These findings, in the setting of high vaccination coverage, may be considered as a consequence of waning vaccine-induced immunity similar to findings of some researchers, where vaccine-induced immunity lasted for four to 12 years, i.e. six to 10 years [8, 9].

Infants are at the highest risk of pertussis and severe forms of the disease and relatively high age-specific incidence of hospitalized cases in non-sentinel population as well as high incidence in sentinel population shows that pertussis still represents a problem among infants too young to be completely immunized according to schedule of immunization [8].

The lowest age-specific incidence rates in adults was most probably the consequence of unrecognizing the disease in the setting of unrecognized endemic/epidemic character of the disease occurrence, making adults significant sources of transmission of *B. pertussis* to unvaccinated young infants. Adults most probably did not seek medical attention due to mild forms of illness.

Until the introduction of improved pertussis surveillance, pertussis was considered to be a childhood disease in unvaccinated children of the youngest age group. However, 19.2% (28/146) of cases in our study were detected in adults through improved surveillance. It is still lower than in some developed European countries [7, 10–13]. It can be the result of high seroprevalence due to unrecognized infections, less exposition to infection, insufficient sensitivity of clinical case definition, or the consequence of the current situation in regard to the cyclical nature of the disease [14].

CONCLUSION

Introduction of clinical case definitions proposed by GPI improved the quality of surveillance and enabled an insight in the distribution of pertussis in all age groups and at all levels of health care.

Sentinel surveillance provided better perception of pertussis incidence rates in the population of Novi Sad.

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REFERENCES

1. Black RE, Cousens S, Johnson HL, Lawn JE, Rudan I, Bassani DG, at al. Global, regional, and national causes of child mortality in 2008: a systematic analysis. Lancet. 2010; 375(9730):1969–87.
2. Wright SW, Edwards KM, Decker MD, Zeldin MH. Pertussis infection in adults with persistent cough. JAMA. 1995; 273(13):1044–6.
3. Cherry JD, Tan T, Wirsing von König CH, Forsyth KD, Thisyakorn U, Greenberg D, et al. Clinical definitions of pertussis: Summary of a Global Pertussis Initiative roundtable meeting, February 2011. Clin Infect Dis. 2012; 54(12):1756–64.
4. Seguljev Z, Petrović V, Cosić G, Durić P, Petrović M, Ilić S. Effects of the immunization program in Vojvodina. Med Pregl. 2007; 60(11–12):553–7.
5. Zakon o zaštiti stanovništva od zaraznih bolesti, Službeni glasnik RS, 125/04.
6. Wendelboe AM, Hudgens MG, Poole C, Van Rie A. Estimating the role of casual contact from the community in transmission of Bordetella pertussis to young infants. Emerg Themes Epidemiol. 2007; 4:15.
7. EUVAC.NET. Pertussis Surveillance Report 2010. Accessed 2015 November 20. Available from: http://www.ecdc.europa.eu/en/publications/Publications/pertussis_report_2010_euvacnet.pdf
8. Wendelboe AM, Van Rie A, Salmaso S, Englund JA. Duration of immunity against pertussis after natural infection or vaccination. Pediatr Infect Dis J. 2005; 24(5 Suppl):S58–61.
9. Wood N, McIntyre P. Pertussis: review of epidemiology, diagnosis, management and prevention. Paediatr Respir Rev. 2008; 9(3):201–11.
10. Heininger U, Klich K, Stehr K, Cherry JD. Clinical findings in Bordetella pertussis infections: results of a prospective multicenter surveillance study. Pediatrics. 1997; 100(6):E10.
11. Amirthalingam G, Gupta S, Campbell H. Pertussis immunisation and control in England and Wales, 1957 to 2012: a historical review. Euro Surveill. 2013; 18(38).
12. Wiese-Posselt M, Hellenbrand W. Changes to the varicella and pertussis immunisation schedule in Germany 2009: background, rationale and implementation. Euro Surveill. 2010; 15(16). Accessed 2015 December 15. Available from: http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19548.
13. Sizaire V, Garrido-Estepa M, Masa-Calles J, Martinez de Aragon MV. Increase of pertussis incidence in 2010 to 2012 after 12 years of low circulation in Spain. Euro Surveill. 2014; 19(32).
14. Gonfiantini MV, Carloni E, Gesualdo F, Pandolfi E, Agricola E, Rizzuto E, at al. Epidemiology of pertussis in Italy: disease trends over the last century. Euro Surveill. 2014; 19(40):20921.

Инциденција пертусиса у Новом Саду (Србија) пре и у току унапређеног надзора

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САЖЕТАК

Увод/Циљ У циљу унапређења надзора над пертусисом, нарочито код старије деце, адолесцената и одраслих, Глобална пертусис иницијатива (ГПИ) предложила је клиничке дефиниције пертусиса за три различите узрасне кохорте. Циљ овог истраживања је да упореди регистровано оптерећење пертусисом у новосадској популацији пре и после увођења унапређеног надзора у коме су коришћене клиничке дефиниције пертусиса предложене од ГПИ.

Методе Подаци о регистрованом оптерећењу пертусисом су добијени на основу извештаја из рутинског (непредострожног) надзора. Унапређен надзор (предострожни и болнички), у којем је сумња на пертусис постављана у складу са клиничким дефиницијама ГПИ, уведен је 16. септембра 2012. године, док у несентинелном надзору клиничка дефиниција пертусиса није уведена. За лабораторијску потврду дијагнозе су од свих суспектних случајева узети назофаингеални брис и/или узорак крви, а испитивање је, у зависности од трајања кашља и узраста пацијента, вршено молекуларном (ПЦР) или серолошком методом. За статистичку обраду података коришћен је *SPSS Statistics* 22.

Резултати Током анализираног периода пре увођења унапређеног надзора (око 12 година) на основу клиничке слике су пријављена само два случаја пертусиса, док је у двогодишњем периоду спровођења надзора регистровано 14 (сезона 2012/2013), односно 146 (сезона 2013/2014) случајева и доказане су сигнификантне разлике у распрострањености ове болести у популацији у зависности од врсте надзора и нивоа здравствене заштите.

Закључак Увођењем клиничких дефиниција предложених од ГПИ унапређен је квалитет надзора и сагледавање учесталости пертусиса у свим добним групама и на свим нивоима здравствене заштите.

Кључне речи: пертусис; надзор; епидемиологија