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Analysis of the Incidence of Tick-Borne Encephalitis as an Occupational Disease and of the Costs of the Diagnosis and Treatment of Acute Tick-Borne Encephalitis in the Slovak Republic from 1989 to 2009

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1. Introduction

Tick-borne encephalitis is a viral disease of the central nervous system that is caused by flaviviruses. The disease can be mild; however, in 35 to 58% of cases, the course of the disease includes long-lasting neurological problems, and the disease can be lethal in 1 to 5% of cases (WHO, 2011). The first symptoms appear about 7 days (incubation period 2 to 28 days) after an infected tick latches on to its host and may present as a flu-like illness. In some people, the second phase of the disease begins after 2 to 4 weeks and is characterised by violent headache, disorientation and high fever; eventually, the patient may lose consciousness, and in many cases, this stage is followed by a long convalescence.

Ixodes ricinus, the three-host tick species is parasitic on various stages of development in different hosts, is a disease vector. The larvae is parasitic on small mammals, lizards and birds searching for food on the ground; the nymph is parasitic on larger mammals (hedgehog, squirrel), birds and occasionally on rodents and the imago is parasitic on large mammals (rabbit, fox, deer, wild boar, goat, sheep, cattle, etc.). Imago's activity in nature is highest from March to October, usually with two peaks: the first peak occurs in June and July, and the second peak occurs in September and October (Grešíková, 1999). The virus is found in the saliva of the tick in all developmental stages but does not harm its host. Humans are infected when they are bitten by an infected female tick. Humans are also infected in alimentary ways, such as by goat, cow or sheep milk and cheese that are insufficiently thermally modified, but this happens less often (WHO, 2009).

During the last decade, a shift of infected ticks to the northern regions of Europe and to higher altitudes has been observed. As a result, an increase in the incidence of tick-borne encephalitis has occurred in new locations in Europe and in the Slovak Republic.

In the Slovak Republic, the employer is responsible for the damage that is caused to the professional staff by acute occupational poisoning, acute occupational infectious disease and

occupational disease, according to the current legislation. The employer is obliged to provide compensation for loss of earnings, pain and suffering, and he must eventually compensate the employee for a loss of social status. The goal of this study was to evaluate the incidence of tick-borne encephalitis as an occupational disease in Slovakia and in the Czech Republic from 1989 to 2009 and to compare it with the incidence in the general population. We also analysed the average direct and indirect costs of the diagnosis and treatment of acute tick-borne encephalitis in Slovakia. We also wanted to point out the possible financial impact of the disease on employers for compensating workers for occupational disease, compared with the costs of active prevention of the infection of employees by vaccination.

2. Material and methods

We have analysed data that was obtained from the Epidemiological Information System of the Public Health Authority of the Slovak Republic, the National Health Information Centre of the Slovak Republic, the National Institute of Public Health of the Czech Republic and the Institute for Health Information and Statistics of the Czech Republic for the period from 1989 to 2009. Admission criteria for the detection of disease in the Epidemiological Information System of the Slovak Republic and the National Institute of Public Health of the Czech Republic, respectively, were infectious diseases, tick-borne encephalitis, diagnosed according to International Classification of Diseases ICD-10 A84.1 during the period from 1989 to 2009. Identification data were age, sex, and epidemiological data, which included the mechanism of transmission, the location and the period of infection. According to the entry criteria, the absolute and relative numbers of the disease, the location of disease and the incidence by sex and age group were assessed. From the Epidemiological Information System of the Slovak Republic data from 2009, we evaluated the clinical form of disease, the number of hospitalisation days, the locality of isolation and the subject's occupation.

When analysing the data on the occupational diseases from statistical surveys from the Slovak Republic and the Czech Republic, the Slovak Republic entry criterion for the disease was from file "26 - diseases transmissible from animals to humans either directly or through vector", and the Czech Republic identification was through registration code 5.02.12, specifically "V.02.12 viral encephalitis transmitted by ticks."

We based the analysis of occupations for the unification of the data for the Slovak Republic and the Czech Republic on the classification of economic activities. We included the building industry, manufacturing and electricity, gas and water and activity of social organisations in the group that was called "others."

A more detailed age professional analysis of reported occupational tick-borne encephalitis in the Slovak Republic was performed according to data that was obtained from four claiming departments: the Department of Occupational Medicine and Toxicology at the University Hospital in Martin, the Department of Occupational Medicine and Clinical Toxicology of Pavol Jozef Šafárik University in Košice, the Department of Occupational Medicine and Toxicology of Medical Faculty Comenius University in Bratislava and the Department of Occupational Medicine and Toxicology of Roosevelt Hospital in Banská Bystrica.

Furthermore, we performed a retrospective analysis of the direct and indirect costs for patients who were hospitalised with a diagnosis of tick-borne encephalitis in the Slovak

Republic in 2009. The data for each patient were received from the Epidemiological Information System of the Slovak Republic. According to the General Health Insurance Company (VšZP a.s.) data and the medical records of patients who were hospitalised at the University Hospital in Martin, we calculated the direct costs of diagnosis and treatment during hospitalisation in 2009. Direct costs include the cost of the total time in the hospital ("finished hospitalisation") and the cost of laboratory and imaging tests, which are common diagnostic and therapeutic components.

Indirect costs include the costs that were paid by employers in the form of wages, sickness benefits paid by social insurance and loss of productivity due to lower gross of domestic product during the hospitalisation of the patient. In the Slovak Republic, the employer pays income compensation for economically active patients during the first ten days of working disability: 25% of the daily earnings for the first three days and 55% for the remaining days (Act No. 461, 2003; Act No. 462, 2003). After the tenth day of working disability, the Social Insurance Company pays sickness benefits that are 55% of the daily earnings. We based the calculations of cost on the cost of the minimum monthly wage, which was 295.50 EUR for 2009 (Decree No. 422, 2008). To calculate the productivity loss, we used the amount of gross domestic product per citizen per day, which amounted to 32.03 EUR in 2009 (Statistical Office of the Slovak Republic, 2010).

Patients were divided into three age groups: up to 14 years of age, from 15 to 64 years of age and over 65 years of age. For the analysis, we included only economically active hospitalised patients who were over 15 years of age, excluding students and pensioners.

For the evaluation of the results, we used descriptive methods of statistical analysis (Microsoft Office Excel 2007 and statistical program SPSS version 11.0). Values of $p < 0.05$ were considered to be statistically significant.

3. Results

3.1 The incidence of tick-borne encephalitis reported by the Epidemiological Information System of the Slovak Republic and the National Institute of Public Health of the Czech Republic

For the designated period, there were 1,299 cases of tick-borne encephalitis reported in the Slovak Republic and 11,714 cases reported in the Czech Republic (table 1). The average incidence of tick-borne encephalitis in the last 21 years was 1.2 cases per 100,000 people in the Slovak Republic and 5.4 cases per 100,000 people in the Czech Republic.

The number of reported cases in the Slovak Republic and in the Czech Republic tends to have a slightly upward trend (figure 1).

3.2 Occurrence of occupational tick-borne encephalitis reported by the departments of Occupational Medicine and Toxicology in the Slovak Republic and departments of Occupational Diseases in the Czech Republic

In the Slovak Republic from 1989 to 2009, there were 22 cases of diagnosed occupational tick-borne encephalitis, and in the Czech Republic, there were 190 cases during the same period (table 2).

Of these reported cases of occupational tick-borne encephalitis, there was an equal proportion of men and women (50%) in the Slovak Republic. A statistically significant difference was found between genders in the Czech Republic, where the male sex represented 71.0% of the cases, and the women represented 29.0% of the cases.

	Slovak Republic		Czech Republic	
year	n	incidence/100,000	n	incidence/100,000
1989	18	0.3	166	1.3
1990	14	0.3	193	1.9
1991	24	0.5	356	3.5
1992	16	0.3	338	3.3
1993	51	1.0	629	6.1
1994	60	1.I	613	5.9
1995	89	1.6	744	7.2
1996	101	1,9	571	5.5
1997	73	1.4	415	4.0
1998	57	1.1	422	4.1
1999	63	1.2	490	4.8
2000	92	1.7	719	7.0
2001	75	1.4	633	6.2
2002	62	1.2	647	6.3
2003	74	1.4	606	5.9
2004	70	1.3	507	5.0
2005	50	0.9	643	6.3
2006	91	1.7	1,029	10.0
2007	58	1.1	546	5.3
2008	84	1.6	631	6.1
2009	77	1.4	816	7.8
Total	1,299	1.2	11,714	5.4

Table 1. Number of reported cases of tick-borne encephalitis in the Slovak Republic and the Czech Republic from 1989 to 2009 (source: Epidemiological Information System of the Slovak Republic, National Institute of Public Health of the Czech Republic)

The number of reported cases of occupational tick-borne encephalitis has demonstrated a slight downward trend in the Slovak Republic; a statistically significant downward trend in reported occupational diseases is present in the Czech Republic (figure 2).

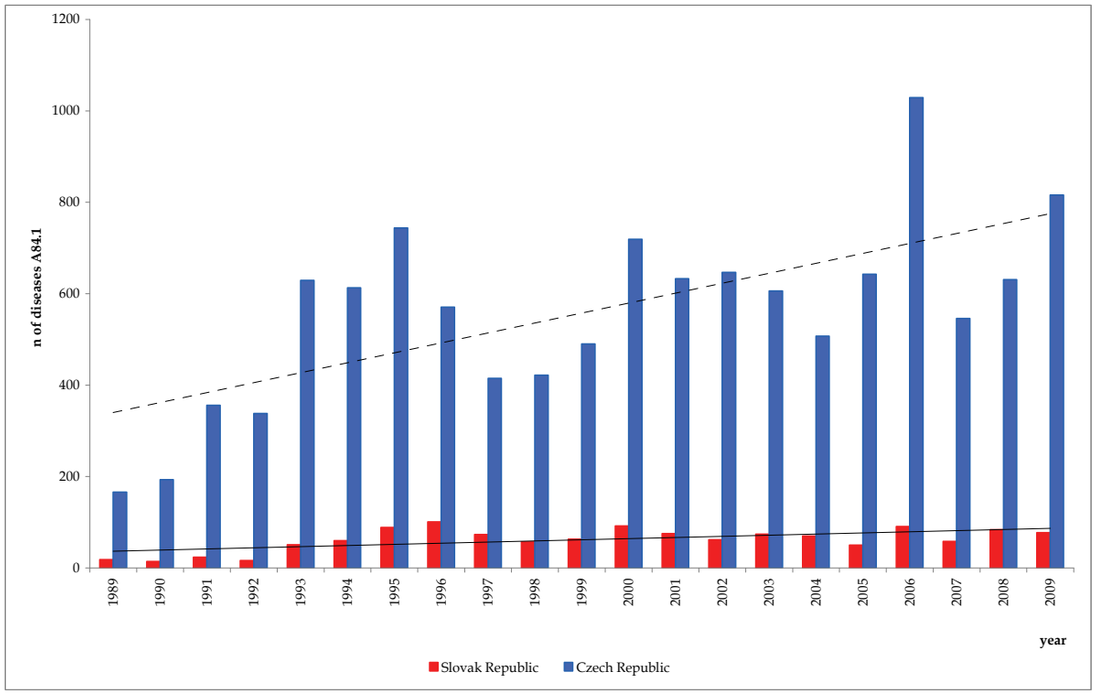

Fig. 1. Number of reported cases of tick-borne encephalitis in the Slovak Republic and the Czech Republic from 1989 to 2009 (source: Epidemiological Information System of the Slovak Republic, National Institute of Public Health of the Czech Republic)

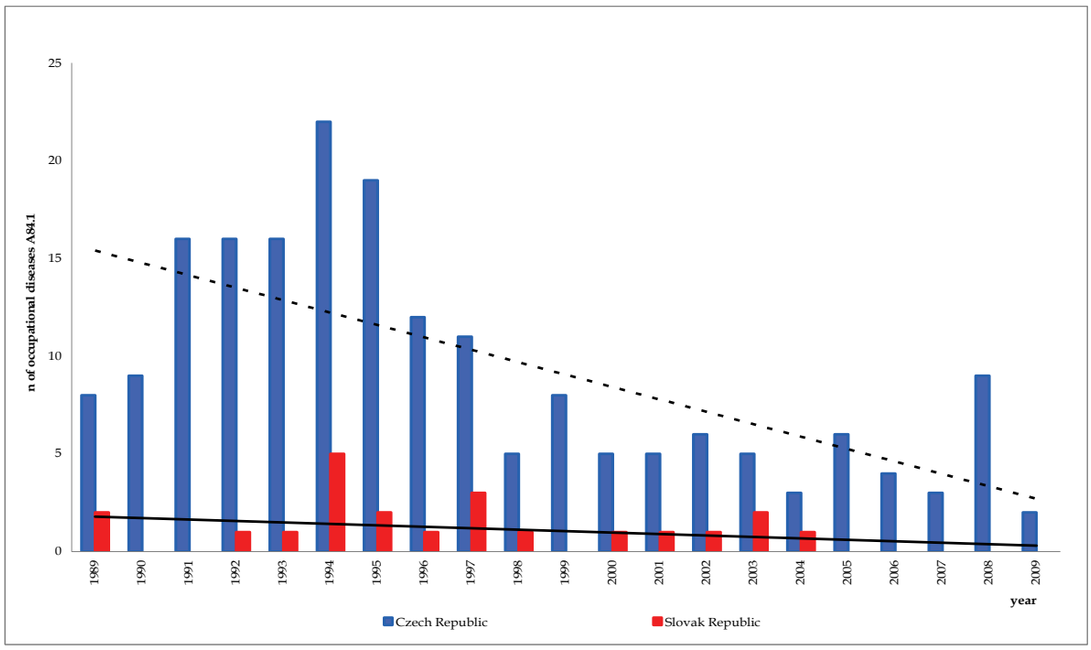

Fig. 2. Number of reported occupational diseases according to the diagnosis of tick-borne encephalitis A84.1 and according to sex (source: National Health Information Centre of the Slovak Republic, National Institute of Public Health of the Czech Republic)

	Slovak Republic					Czech Republic				
year	n total	n male	% male	n female	% female	n total	n male	% male	n female	% female
1989	2	1	50.0	1	50.0	8	5	62.5	3	37.5
1990	0	0	0.0	0	0.0	9	7	77.8	2	22.2
1991	0	0	0.0	0	0.0	16	13	81.2	3	18.8
1992	1	1	100.0	0	0.0	16	13	81.2	3	18.8
1993	1	0	0.0	1	100.0	16	11	68.8	5	31.2
1994	5	3	60.0	2	40.0	22	15	68.2	7	31.8
1995	2	1	50.0	1	50.0	19	14	73.7	5	26.3
1996	1	1	100.0	0	0.0	12	7	58.3	5	41.7
1997	3	2	66.7	1	33.3	11	9	81.8	2	18.2
1998	1	1	100.0	0	0.0	5	4	80.0	1	20.0
1999	0	0	0.0	0	0.0	8	5	62.5	3	37.5
2000	1	1	100.0	0	0.0	5	1	20.0	4	80.0
2001	1	0	0.0	1	100.0	5	5	100.0	0	0.0
2002	1	0	0.0	1	100.0	6	5	83.3	1	16.7
2003	2	0	0.0	2	100.0	5	3	60.0	2	40.0
2004	1	0	0.0	1	100.0	3	2	66.7	1	33.3
2005	0	0	0.0	0	0.0	6	5	83.3	1	16.7
2006	0	0	0.0	0	0.0	4	2	50.0	2	50.0
2007	0	0	0.0	0	0.0	3	2	66.7	1	33.3
2008	0	0	0.0	0	0.0	9	6	66.7	3	33.3
2009	0	0	0.0	0	0.0	2	1	50.0	1	50.0
Total	22	11	50.0	11	50.0	190	135	71.0	55	29.0

Table 2. Number of reported occupational diseases according to the diagnosis of tick-borne encephalitis A84.1 and according to sex (source: National Health Information Centre of the Slovak Republic, National Institute of Public Health of the Czech Republic)

The incidence of occupational tick-borne encephalitis in proportion to the total number of occupational diseases in the Slovak Republic and the Czech Republic is listed in table 3 and figure 3. These data are processed for the time period from 1993 to 2009; due to the reclassification of occupational diseases in miners in the period from 1990 to 1992 in both republics, an enormous increase in the number of reported occupational diseases occurred.

Using data for the period from 1989 to 1992 would result in a misrepresentation of the total number of cases of occupational tick-borne encephalitis. In the Slovak Republic, occupational tick-borne encephalitis represents, on average, only 0.2% of all annually reported occupational diseases during the designated time period and exhibits a downward trend. In the Czech Republic, the proportion is almost twice as high; occupational tick-borne encephalitis represents only 0.3% of the total number of reported occupational diseases, but the trend is also downward.

	Slovak Republic			Czech Republic		
	occupational diseases	professional disease of tick-borne encephalitis		occupational diseases	professional disease of tick-borne encephalitis	
year	n	n	%	n	n	%
1989	1,041	2	0.2	4,846	8	0.2
1990*	1,194	0	0.0	11,575	9	0.1
1991	1,311	0	0.0	8,697	16	0.2
1992	1,076	1	0.1	3,393	16	0.5
1993	939	1	0.1	2,983	16	0.5
1994	722	5	0.7	2,684	22	0.8
1995	601	2	0.3	2,852	19	0.7
1996	726	1	0.1	2,543	12	0.5
1997	697	3	0.4	2,376	11	0.5
1998	740	1	0.1	2,111	5	0.2
1999	673	0	0.0	1,886	8	0.4
2000	660	1	0.2	1,751	5	0.3
2001	577	1	0.2	1,677	5	0.3
2002	609	1	0.2	1,600	6	0.4
2003	551	2	0.4	1,558	5	0.3
2004	613	1	0.2	1,388	3	0.2
2005	413	0	0.0	1,400	6	0.4
2006	504	0	0.0	1,216	4	0.3
2007	575	0	0.0	1,291	3	0.2
2008	429	0	0.0	1,403	9	0.6
2009	483	0	0.0	1,313	2	0.2
SPOLU	15,134	22	0.2	60,543	190	0.3

* reclassification of occupational diseases in the Czech Republic

Table 3. Number of occupational tick-borne encephalitis cases in proportion to the total number of occupational diseases (source: National Health Information Centre of the Slovak Republic, National Institute of Public Health of the Czech Republic)

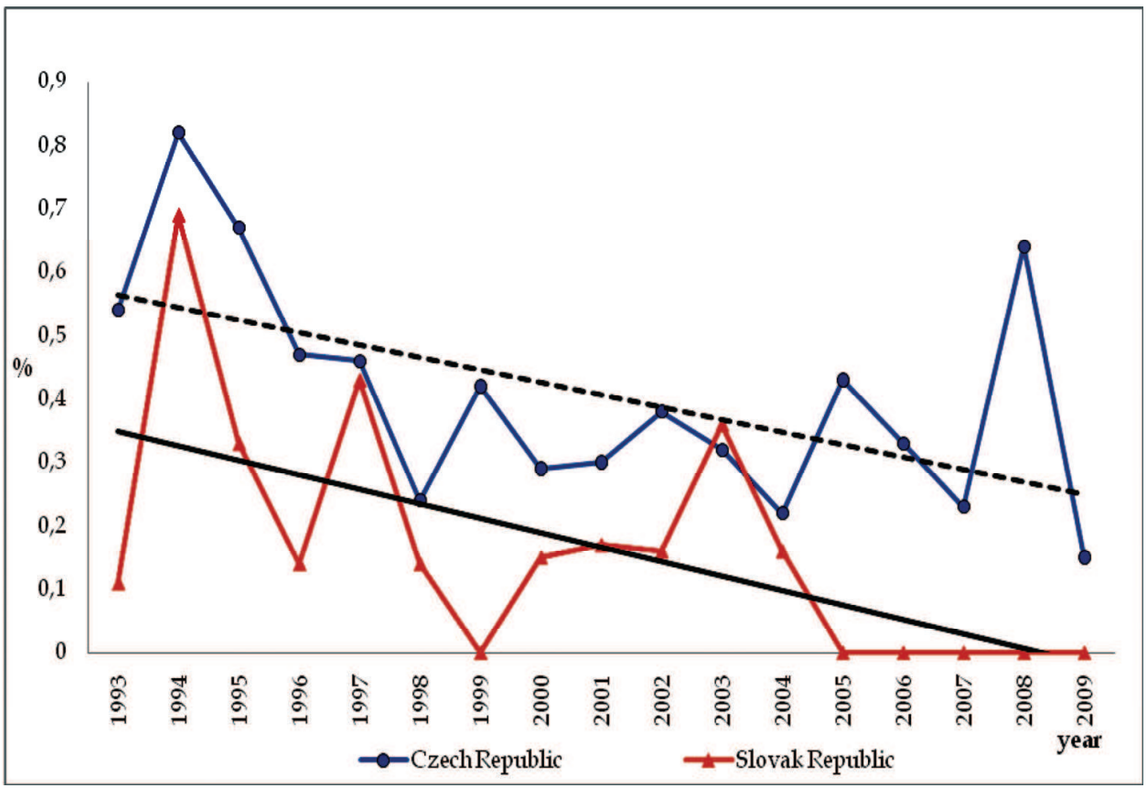

Fig. 3. Number of cases of occupational tick-borne encephalitis in proportion to the total number of occupational diseases (source: National Health Information Centre of the Slovak Republic, National Institute of Public Health of the Czech Republic)

3.3 Age-professional analysis of the incidence of tick-borne encephalitis as an occupational disease in the Slovak Republic

In table 4, the occurrence of occupational tick-borne encephalitis according to industrial classification is shown. In the Czech Republic, the highest number of cases was 117 in the forestry sector (62.2%); 15 cases (7.9%) occurred in both the agriculture and transport sectors.

A more detailed analysis by occupation, sex and age could be done for the Slovak Republic alone. Based on the analysis of the data from four workplaces in the Slovak Republic, there were 22 cases of occupational tick-borne encephalitis, and the highest incidence of the disease occurred in the group of 45 to 54 year-olds. The average age in the reported cases was 46.9 ± 7.8 years. Women were represented the most frequently in the 35 to 44 year-old and 45 to 54 year-old age groups, and men were represented most frequently in the 45 to 54 year-old age groups.

The most frequent occurrence of occupational tick-borne encephalitis was recorded in the forestry sector, which had 17 cases (77.2%); 11 of these cases were female forest workers, 4 were chainsaw operators, 1 was a forester and 1 was a forest management planner. The agriculture sector had 3 cases (13.6%), of which 2 were tractor drivers, and 1 was a nurse for sheep. One case was reported in the public sector administration and defence (a guard dog handler), and one case was classified in the "others" category (a technique of protective circuits).

	Slovak Republic						Czech Republic	
	n total	%	n male	% male	n female	% female	n total	%
agricultural	3	13.6	3	27.2	0	0.0	15	7.9
forestry	17	77.2	6	54.6	11	100.0	117	61.5
fishery	0	0.0	0	0.0	0	0.0	4	2.1
freight	0	0.0	0	0.0	0	0.0	15	7.9
public administration and defence	1	4.6	1	9.1	0	0.0	11	5.8
educational	0	0.0	0	0.0	0	0.0	11	5.8
health service	0	0.0	0	0.0	0	0.0	3	1.6
other activities	1	4.6	1	9.1	0	0.0	14	7.4
Total	22	100.0	11	100.0	11	100.0	190	100.0

Table 4. Number of reported occupational diseases according to the diagnosis of tick-borne encephalitis A84.1 and according to economic activities from 1989 to 2009 (source: National Health Information Centre of the Slovak Republic, National Institute of Public Health of the Czech Republic)

3.4 Direct and indirect costs of diagnosis and treatment of tick-borne encephalitis during hospitalisation in the Slovak Republic in 2009

During the observed period, 77 cases of tick-borne encephalitis were reported in the Slovak Republic. The disease did not require hospitalisation in 4 patients who were older than 15 years. Altogether, 73 patients were hospitalised, 50 (68.5%) males and 23 (31.5%) females. In subjects up to 14 years old, there were 5 patients, and in the group of subjects who were over 15 years old, there were 68 patients. There were 52 economically active hospitalised patients. Their average age was 41.6 years (18 to 62 years), their average length of hospital stay was 11.8 days (3 to 29 days), and together they accumulated 613 days of hospitalisation (table 5). When comparing the sexes, we did not find statistically significant differences in the age or in the length of hospitalisation in the economically active population of inpatients.

In 2009, VšZP a.s. spent 34,992.74 EUR for the diagnosis and treatment of patients who were diagnosed with tick-borne encephalitis. Expenses for the constitutional health care (inpatients) accounted for 57% of the expenses, the cost of laboratory and imaging diagnosis accounted for 32%, the cost of specialised ambulatory care (outpatients) accounted for 6% and drug costs accounted for 5% of the total expenses for this health insurance company (figure 4).

Average direct expenses for hospitalised patients in 2009, calculated from VšZP a.s. data and available medical records, equalled 901.37 EUR (511.98 EUR to 2,927.39 EUR). For 52

economically active hospitalised patients, the total direct expenditures of the health insurance company equalled 46,871.24 EUR.

	0 - 14	**15 - 64**	**65+**	**total**
number of inpatients	5 (6.9%)	61 (83.6%)	7 (9.6%)	73
age	8.4 ± 3.2	40.3 ± 13.8	72.4 ± 10.6	41.2 ± 18.2
length of hospitalization	14.6 ± 1.7*	11.5 ± 4.3	10.7 ± 2.8	11.6 ± 4.1
days of hospitalization	73	701	75	849
form	n (male + female)	n (male + female)	n (male + female)	
febrile	1 (0 + 1)	16 (11 + 5)	0	17 (23.39%)
meningeal	4 (1 + 3)	44 (32 + 12)	7 (5 + 2)	55 (75.3%)
neurological	0	1 (1 + 0)	0	1 (1.4%)

* $p < 0,05$

Table 5. Patients hospitalised with a diagnosis of tick-borne encephalitis in the Slovak Republic in 2009 (source: Epidemiological Information system of the Slovak Republic)

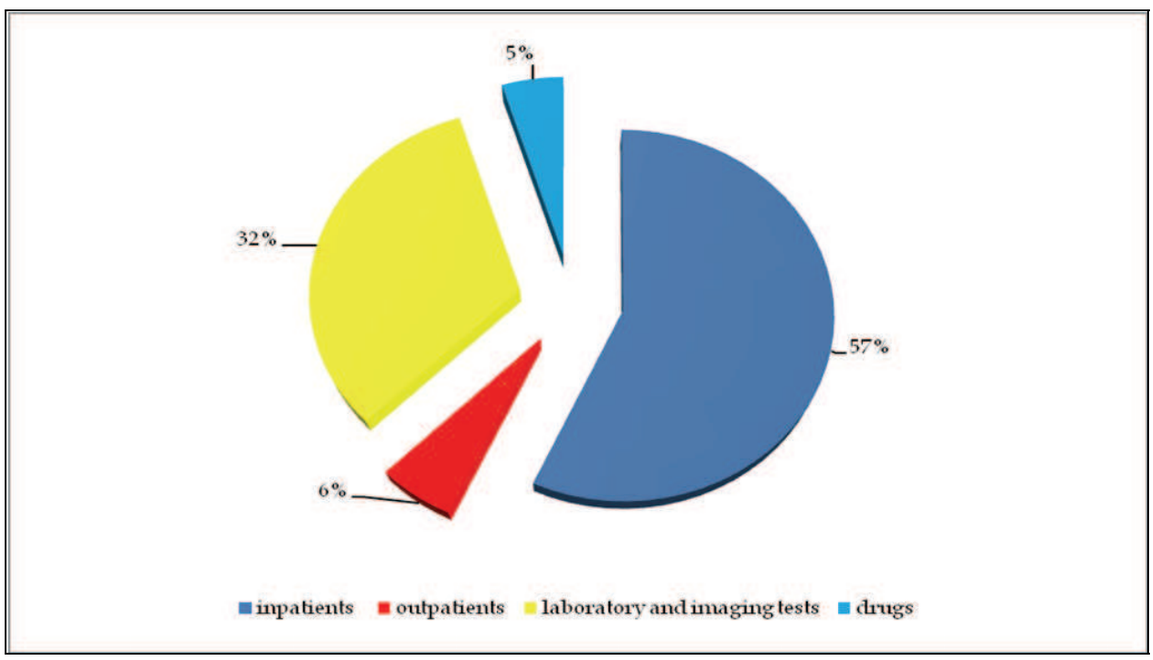

Fig. 4. The total direct costs of the VšZP a.s. for tick-borne encephalitis according to the type of healthcare in 2009 (source: VšZP a.s.)

The indirect costs for 52 economically active hospitalised patients at a minimum monthly salary would be 76.56 EUR (10.07 EUR to 202.15 EUR) for 12 days of working disability. The loss of earnings for a patient for 12 days of working disability was 84.57 EUR (30.22 EUR to 187.37 EUR). Indirect costs in the form of the loss of productivity at work and a decrease in gross domestic product would have reached 19,634.39 EUR at a minimum monthly salary. The total indirect cost for these patients was 23,534.32 EUR (table 6).

	for 12 day of hospitalization	**for 52 of hospitalized patients**
direct costs	**EUR**	**EUR**
expenditures during hospitalization	901.37	46,871.24
indirect costs		
loss for the state	460.92	23,534.32
income compensation, sickness benefit	76.56	3,899.93
loss of gross of domestic product	384.36	19,634.39
total direct and indirect costs	1,362.29	70,405.56
loss of income for empoyee	84.57	4,333.78

Table 6. Direct and indirect costs for 52 economically active patients who were hospitalised with a diagnosis of tick-borne encephalitis in the Slovak Republic in 2009

3.5 Occupational tick-borne encephalitis and financial compensation

By law, the employee has to be compensated for pain and possibly for difficulties in society that are a result of an occupational injury. A scoring system for pain is defined in Annex No. 1 in section III., and the scoring system for difficulties in society is defined in Annex No. 1 in section IV. of Act No.437/2004 (Act No. 437, 2004). The basic scores for pain that is related to occupational diseases for tick-borne encephalitis are, according to Annex No. 1, section III., item 41, "The acute forms of infectious and parasitic diseases," ranging from 30 to 150 points. The basic score for difficulty in society for the occupational diseases are, according to Annex No. 1, section IV., item 46, "The results of the TBE," ranging from 300 to 3000 points. The amount of compensation for pain and the amount of compensation for difficulties in society was set at 14.46 EUR per point for 2009 (Measure of Ministry of Health of the Slovak Republic, 2009).

In 2009 in the Slovak Republic, the average price of the tick-borne encephalitis vaccine FSME-IMMUN was 19.07 EUR; ENCEPUR ADULTS was 16.85 EUR. The median life expectancy in Slovakia being 71.3 years in men and 78.7 years in women (Statistical Office of the Slovak Republic, 2010). If the first vaccination was implemented at 18 years of age and was being implemented till death, about 15 doses of vaccine would be required (table 7).

The cost for the 15 doses of vaccine at the prices from 2009 would amount to 286.05 EUR (FSME-IMMUN), respectively 252.75 EUR (ENCEPUR ADULTS).

	EUR		
	min	max	average
rate for the pain on occupational diseases (30 – 150 points)	433.8	2,169.00	1,301.40
rate for difficulty in society (300 – 3000 points)	4,338.00	43,380.00	23,859.00
average direct and indirect costs for one inpatient	618.14	4,058.41	1,362.29
average prices for 15 doses of vaccine	252.75	286.05	269.40
utility costs	365.39	3,772.36	1,092.89

Table 7. Comparison of financial compensation and the price of vaccines at the minimum rates in the Slovak Republic in 2009

4. Discussion

The purpose of our study was to map the occurrence of tick-borne encephalitis in the Slovak Republic, since the statistics of the National Health Information Centre of the Slovak Republic are not currently tracked nor is tick-borne encephalitis analysed as a separate occupational infectious diseases problem. Occupational tick-borne encephalitis is reported in a group of diseases that are transmissible directly from animals to humans or transmissible by the carriers. Tick-borne encephalitis is separately mentioned only to indicate the patient's gender and the location of the medical facility. Similarly, in the Czech Republic, tick-borne encephalitis is separately monitored only to indicate the patient's gender and the area of the origin of the occupational diseases. Details regarding the age groups, the length of the exposure and the sections and classes of economic activities are reported in the Slovak Republic and Czech Republic together for all the diseases that can be transmitted from animals to humans.

Issues of the occurrence of tick-borne encephalitis and other diseases that are transmitted by ticks were addressed by other countries. In the Netherlands, for example, the foresters` antibody levels were monitored (Charante et al., 1998). At high exposure the prevalence odds ratios (with 95% CI between brackets) were for tick-borne encephalitis 1.0 (0.3 to 3.0), and for Lyme borreliosis 15 (5.5 to 42). Similarly, France has confirmed the presence of antibodies in workers who are at risk. Among the 2,975 subjects included in the study, the observed seroprevalence were 3.4% for tick-borne encephalitis and 14.1% for Lyme borreliosis (Thorin et al., 2008). In the Slovak Republic and the Czech Republic, we have confirmed the presence of occupational tick-borne encephalitis, particularly among forestry workers.

Despite the fact that the tick-borne encephalitis virus is transmitted by only about 1 to 2% of ticks (Máderová, 2005), it can be expected that with failure to provide preventive measures,

the number of occupational cases of tick-borne encephalitis will increase. There are fields that demonstrate an increased number of the infected ticks in Europe, especially in Germany, the Czech Republic, Poland, Switzerland, Sweden, Finland, the Slovak Republic, Hungary, Slovenia and Austria (Suss, 2008).

In the Slovak Republic in the past, 33 endemic areas of tick-borne encephalitis were located in the districts of Nitra, Komarno, Bratislava and Rožňava (Máderová, 2005). Currently, 37 areas of endemic outbreaks have been identified, especially in Tribeč, Vtáčnik, Nitrianska pahorkatina, Pohronská pahorkatina and the Vah valley down to the Považská Bystrica district, Malé Karpaty, Záhorská nížina, Kováčske kopce, Krupinská planina, Slovenský Kras and Slánske vrchy (Slováková, 2008).

In the Slovak Republic, the risk of possible occupational health hazards due to tick-borne encephalitis is not publicized. In a study of the occupational disease Lyme borreliosis, anamnesis data of the patients indicated that during the past few years, there were significant increases in the number of seasonal tick bites, especially while working on slopes situated on the southern side and in the higher areas of Slovakia (Buchancová, 2009). The literature has described the movement of the tick into higher altitudes, exceeding 1,000 m altitude, of northern Slovakia (Peťko et al., 2008). A similar situation is also described in the Czech Republic (Danielová et al., 2008). Failure to provide preventive measures would mean an increase in the occupational cases of tick-borne encephalitis.

Apart from the primary protection, which is generally focused on the prevention of an infection that is transmitted by ticks, active immunisation is a possible protective measure against tick-borne encephalitis for workers who are working in endemic areas. Vaccination is one of the most effective forms of protection against tick-borne encephalitis. In some European countries such as Austria, Finland, Germany, Hungary, Lithuania, Slovenia, Russia and Switzerland, the vaccination is included in the national immunisation programme (Mantke et al., 2008).

In the Czech Republic, the health insurance companies contribute to the prevention of disease. In 2008, all health insurance companies contributed for vaccination and revaccination of children and adolescents, for vaccination of adults ages 19 to 55 years, except Military ("Vojenská zdravotní pojišťovna") and Union health insurance ("Oborová zdravotní pojišťovna"), and for vaccination of people over 55 years old (all with the exception of the Military health insurance) (Dolanský, 2008). According to the available data in the Czech Republic, 17% of the population received immunisation in 2007 (Kříž & Beneš, 2007).

Until August 31, 2009, there was a total of 17,093 vaccinated children under 15 years of age in the Slovak Republic; this means that 2% of this age group was immunised (Public Health Authority of the Slovak Republic, 2010). In Austria, the proportion of the population that is immunised rises up to 88% in places where there is a high occurrence of the disease, and the number of cases of the disease is only counted in tens (Suss, 2008). Currently in the Slovak Republic, two out of three health insurance companies contribute to the package of higher standards for vaccination against tick-borne encephalitis. Dovera Health Insurance Company a.s., for example, refunds only contributions that are made to vaccinate children and adults in the last of three doses of the vaccine (Dovera ZP a.s., 2011). Union Health Insurance Company a.s. currently pays 50% of the cost of three doses of the tick-borne encephalitis vaccine for its members (Union ZP a.s., 2011). There are not available data, which could determine the rate of re-vaccination for the professional workers in the Slovak

Republic and Czech Republic; these workers are at an increased risk of infection by a tick bite and of subsequent inflammation of the brain.

In the Slovak Republic, according to the Ordinance of Ministry of Health No. 585 in 2008, vaccination of the employees of virology laboratories, in which people work with the tick-borne encephalitis virus, is obligatory. In pursuance of doctors' recommendations, the vaccination of people who are professionally exposed to an increased risk of brain inflammation (Ordinance of Ministry of health No.585, 2008) is suggested. In such cases, the employer should pay for the vaccination. The employer and the self-employed should have access to information about the cost of prevention, treatment and, in the case of the employer, the amount financial compensation for employees who are exposed to acute infectious diseases in their occupation.

Tick-borne encephalitis is a disease that can be combated by both nonspecific preventive measures and by specific prevention in the form of vaccination. We calculated that the average direct and indirect cost per patient during hospitalisation for tick-borne encephalitis was 1,353.95 EUR. The average price for 15 doses of the vaccine was 252.75 EUR. The utility cost is 1,092.86 EUR for health insurance and country. For the employer, compensation for low levels of pain (a score of 30 points) would cost 433.80 EUR. It would be cheaper to pay for the employees' vaccination from 18 years of age until retirement than to pay compensation for pain and social difficulties because of an employee's occupational disease.

Considering our results, it is important for Slovakia to consider reimbursement for vaccination as a form of primary prevention for employees, especially if the place of work is in the endemic area. While the economic benefit is obvious, the benefits to health and quality of life are difficult to quantify. After overcoming occupational tick-borne encephalitis, the employees may have permanent residual damage, which may result in the limitation of employment activity, may force a change in employment and may even result in permanent disability. In these cases, the financial costs are increased by the requirement of additional financial compensation for health damage. This compensation is an annuity, which is currently paid in the Slovak Republic through social insurance from accident insurance. The social insurance from accident insurance is paid by the employer and the amount paid is specified according to the security risks of economic activities with the employer (Act No. 461, 2003).

One problem in the forestry industry is that there is a significant group of self-employed workers, especially in the mining, wood processing and handling divisions. They often lack both the necessary information about the risk of infections that are transmitted by ticks and the opportunities to personally ensure the protection of their health through vaccination for tick-borne encephalitis. Also, due to the periodical variation of seasonal workers in the forestry sector, there are insufficient funds for employers to invest in primary prevention (vaccination).

To ensure the efficacy of vaccination, a conventional vaccination scheme requires vaccination three doses of the vaccine and a regular booster dose after three years. People who are 12 to 49 years old should be vaccinated at 5-year intervals after the first booster dose (ENCEPUR) and who are 16 to 60 years old should be vaccinated every 3 to 5 years. People who are older than 60 years should be vaccinated every three years (FSME IMMUN). For the accelerated vaccination scheme, first booster dose is recommended after 12 to 18 months and then every three years. Only among 12 to 49 years old is recommended every five years (ENCEPUR). For FSME IMMUN first booster dose is recommended after 5 to 12

months and then booster every 3 to 5 years among 16 to 60 years of age. For people who are older than 60 years the booster dose is recommended every three years (State Institute for Drug Control 2011a, 2011b).

5. Conclusion

For employers who are considering funding primary prevention by vaccination, it is important to know the risk of the workers' contraction of a disease in endemic areas, the associated treatment costs and the cost of a confirmed occupational disease.

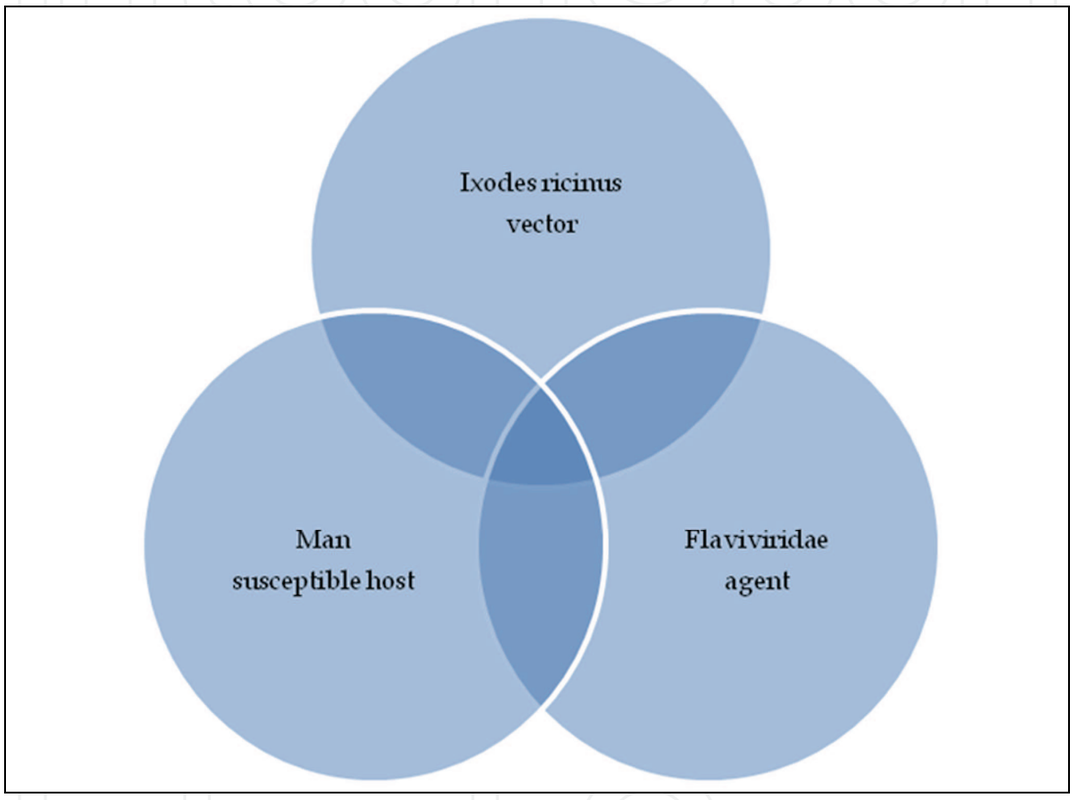

Fig. 5. Relationship between the agent, vector and the susceptible host

Figure 5 shows the relationship between ticks as the vector, the tick-borne encephalitis virus itself and the exposed man. The most common cause of morbidity is a bite by an infected tick and the subsequent development of the disease, which is shown as a result of penetration of the agent, vector and susceptible host in the diagrams. Less frequent morbidity is shown on the diagram as a result of penetration of the agent and a susceptible host, which occurs, for example, with the consumption of contaminated goat milk. An important fact is that, in endemic areas, the population is gradually infected, and after a number of evident and latent diseases, immunity develops at various stages. Non-native people who are visiting endemic areas for recreation or work and at-risk groups of the native population are most susceptible to the disease.

In the Slovak Republic in the past, virus prevalence in the tick populations in the endemic areas was 2.6%. Morbidity of population was 2.2% and the presence of antibodies in healthy

people ranged from 15 to 27% (Grešíková, 1999). The Parasitological Institute of the Slovak Academy of Sciences attempted to assess the immune status of the workers who were working in at-risk professions between 2008 and 2009 by researching tick-borne diseases in hunters and forestry workers from the territory of the Slovak Republic (Parasitological Institute SAS, 2008). Mapping the areas where ticks are present, identifying the new endemic areas and detecting the immune status of the population is extremely important.

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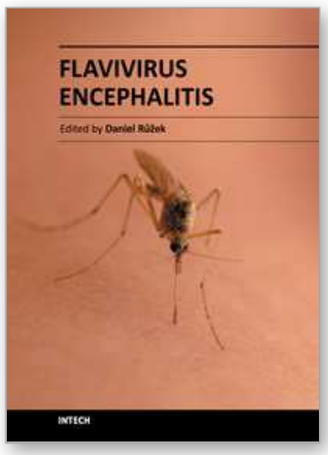

Flavivirus Encephalitis

Edited by Dr. Daniel Ruzek

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Encephalitis is an inflammation of the brain tissue associated with clinical evidence of brain dysfunction. The disease is of high public health importance worldwide due to its high morbidity and mortality. Flaviviruses, such as tick-borne encephalitis virus, Japanese encephalitis virus, Murray Valley encephalitis virus, or St. Louis encephalitis virus, represent important causative agents of encephalitis in humans in various parts of the world. The book Flavivirus Encephalitis provides the most recent information about selected aspects associated with encephalitic flaviviruses. The book contains chapters that cover a wide spectrum of subjects including flavivirus biology, virus-host interactions, role of vectors in disease epidemiology, neurological dengue, and West Nile encephalitis. Special attention is paid to tick-borne encephalitis and Japanese encephalitis viruses. The book uniquely combines up-to-date reviews with cutting-edge original research data, and provides a condensed source of information for clinicians, virologists, pathologists, immunologists, as well as for students of medicine or life sciences.

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