

An Epidemiological Study of Tick-borne Encephalitis in the Tribeč Region: 1953-63

D. BLAŠKOVIČ,¹ G. PUČEKOVÁ,² L. KUBÍNYI,³ S. STUPALOVÁ⁴ & V. ORAVCOVÁ²

As part of an investigation on tick-borne encephalitis in the Tribeč region of Czechoslovakia, an epidemiological study has been carried out on 445 cases diagnosed as "virus meningo-encephalitis" over the period 1953-63. The average morbidity rate was 19.3 per 100 000 inhabitants, ranging from 107.9 in 1955 to 3.3 in 1961. The lowest morbidity rates were in the 0-4 years and 60+ years age-groups (5.7 and 5.5, respectively) and the highest rate was in the 10-14 years age-group (33.2). When the figures for 1960-63 were analysed, the highest rate (21.3) was found among adult farmers and forestry workers. The morbidity rates in the Tribeč region are, on average, 2.6 times those for Czechoslovakia as a whole and 4.7 times those for Slovakia. There is a seasonal variation in incidence, with a maximum in June.

The most frequent method of infection was by tick bite. Villages in the south-east of the region had a higher incidence of disease than those in the north-west. Serological examinations revealed variations in activity within the focus: whereas, of 93 inhabitants of four villages who had suffered from "virus meningo-encephalitis", 63 (68%) had antibodies against tick-borne encephalitis virus, none of 95 randomly selected inhabitants of a village with no reported cases of the disease had antibodies. More accurate diagnosis of the disease has been achieved by the introduction of serological and cultivation procedures.

The tick-borne encephalitis virus was isolated from the brain of the rodent *Clethrionomys glareolus* in habitats in the Tribeč Mountains (Ernek & Škoda, 1958) and later an epidemiological study was carried out on part of this territory (Blaškovič & Karšai, 1962) which provided an analysis of the epidemiological situation for the years 1954-58. Clearly, the results of these studies might not have been characteristic of the entire territory; only an epidemiological analysis of hospitalized patients with tick-borne encephalitis would make it possible to reach definite conclusions concerning the incidence of this infection. Since further data—epidemiological, clinical and those of field investigations into a natural focus—have been accumulating, we decided to study a limited area of the region with

respect to the epidemiological peculiarities of tick-borne encephalitis.

CHARACTERISTICS OF THE AREA STUDIED

The region designated here as the Tribeč region covers an area of about 1760 km². Most of the area is in the Nitra district, but the north-western part is in the Topolčany district and a small part of the south-east is in the Levice district. The Tribeč Mountains are in the centre of the region and their main ridge crosses it diagonally from north-east to south-west. The rest of the region is covered by low-lying plains.⁵

The average population density is 118.6 per km²; the density is higher in the south-east and lower in the north-west. In the mountains there are few inhabitants. The region contains 145 villages and hamlets with a total of 209 290 inhabitants. Seventy-eight villages are situated in the south-east and 67 in the north-west.

¹ Director, Institute of Virology, Czechoslovak Academy of Sciences, Bratislava, Czechoslovakia.

² Regional Sanitary-Epidemiological Station, Bratislava, Czechoslovakia.

³ State Institute of Hygiene, Budapest, Hungary.

⁴ District Sanitary-Epidemiological Station, Nitra, Czechoslovakia.

⁵ See Fig. 3 of the paper by Blaškovič, this Supplement, page 5.

The age structure of the inhabitants is similar to that of inhabitants of west Slovakia—namely, 0-4 years, 9.92%; 5-9 years, 10.62%; 10-14 years, 9.55%; 15-59 years, 58.10%; 60 years and above, 11.81%.

From the economic point of view, the area is predominantly agricultural-industrial. Of the inhabitants of working age, 18.5% are engaged in agriculture and forestry; in the north-west this proportion is higher, reaching 24.2%.

MATERIALS AND METHODS

The analysis involved 445 cases diagnosed as virus meningo-encephalitis in the area studied within the period 1953-63.

The morbidity rate for each year was calculated (as an average and for individual age-groups) and compared with the rates for Czechoslovakia, Slovakia and west Slovakia.

The incidence of the disease was analysed with respect to seasonal variation and locality. Cases occurring in 1960-63 were analysed in detail, with reference to the results of serological examinations and epidemiological anamnesis. Sixty-seven cases were analysed according to age-group and cases among inhabitants aged 15-59 years with respect to occupation.

The clinical picture was evaluated chiefly with respect to a biphasic course, to subclinical cases, and to the diagnosis at the time when the patients were first hospitalized.

In selected villages (Dolné Štitáre, Jarok, Lapáš, Podhorany), a serological examination was carried out in 1962. Virus-neutralization tests were done on sera from 93 patients from the total of 445 who experienced between 1955 and 1959 an acute disease diagnosed as virus meningo-encephalitis.

In Bošany village, 95 blood samples from inhabitants in different age-groups were examined in 1964 for the presence of antibodies against tick-borne encephalitis virus. This village was selected because, although it lies within the survey area, not a single case of virus meningo-encephalitis was reported there for the whole period investigated.

The basic documentation materials were epidemiological cards for each patient, case reports from the infectious disease departments of the district hospitals in Nitra, Zlaté Moravce and Topoľčany, reports from the Department of Virology of the Regional Sanitary-Epidemiology Station at Bratislava and data from the Institute of Virology, Czechoslovak Academy of Sciences, Bratislava.

The information was analysed by the normal statistical methods used in epidemiology and has been summarized in the form of tables and graphs.

RESULTS

In 1953-63, 445 cases diagnosed as virus meningo-encephalitis were reported from the Tribeč area. The average morbidity rate was 19.3 per 100 000 inhabitants; morbidity rates for individual years are given in Table 1. Table 1 also indicates that there are regular fluctuations in annual incidence and that the rate for 1955 was particularly high.

TABLE 1
NUMBER OF CASES OF VIRUS MENINGO-ENCEPHALITIS
AND MORBIDITY RATES: TRIBEČ AREA, 1953-63

Year	Incidence of virus meningo-encephalitis	
	No. of cases	Morbidity rate (per 100 000)
1953	33	15.7
1954	48	22.9
1955	226	107.9
1956	29	13.8
1957	10	4.7
1958	21	10.0
1959	11	5.2
1960	10	4.7
1961	7	3.3
1962	33	15.7
1963	17	8.1
Total	444	19.3

A comparison of the morbidity rates for the Tribeč area with those for Czechoslovakia as a whole and for Slovakia (Table 2) shows the former to be much higher, on average 2.6 times the average annual morbidity rate for Czechoslovakia and 4.7 times that for Slovakia.

Analysis of the morbidity rates by month revealed a seasonal incidence, the number of cases being highest in June (see the figure).

Analysis with respect to age-group (Table 3) showed that the incidence was lowest in the age-groups 0-4 years and 60 years and over, and highest in the 10-14 years age-group. If, however, the

TABLE 2
NUMBER OF CASES OF VIRUS MENINGO-ENCEPHALITIS AND MORBIDITY RATES
IN CZECHOSLOVAKIA, SLOVAKIA AND WEST SLOVAKIA: 1953-63

Year	Incidence of virus meningo-encephalitis					
	Czechoslovakia		Slovakia		West Slovakia ^a	
	No. of cases	Morbidity rate (per 100 000)	No. of cases	Morbidity rate (per 100 000)	No. of cases	Morbidity rate (per 100 000)
1953	2 083	16.3	267	7.4		
1954	1 592	12.3	241	6.6		
1955	1 230	9.4	343	9.2		
1956	804	6.1	121	3.2		
1957	934	7.0	84	2.2		
1958	865	6.4	110	2.8	50	2.9
1959	409	3.0	110	2.8	71	4.1
1960	1 175	8.6	217	5.4	58	3.3
1961	621	4.5	57	1.4	48	2.7
1962	373	2.7	88	2.1	62	3.4
1963	777	5.6	92	2.1	56	3.1

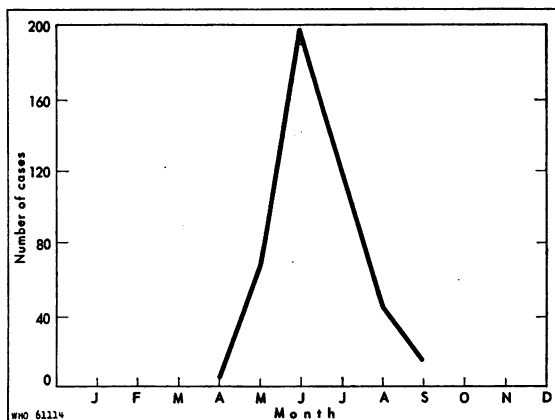
^a Data for west Slovakia for 1953-57 are not included because of territorial changes that took place in 1958.

TABLE 3
AGE DISTRIBUTION OF VIRUS MENINGO-ENCEPHALITIS
IN THE TRIBEČ AREA: 1953-63

Age-group (years)	Incidence of virus meningo-encephalitis	
	No. of cases	Morbidity rate (per 100 000) ^a
0-4	13	5.7
5-9	53	21.7
10-14	73	33.2
15-59	291	21.7
60+	15	5.5
Total	445	19.3

^a Rate is calculated per annum per 100 000 inhabitants in the relevant age-group.

SEASONAL INCIDENCE OF VIRUS
MENINGO-ENCEPHALITIS IN THE TRIBEČ AREA : 1953-63



working population is divided into those working in agriculture and forestry and those in other occupations, the former are seen to have the highest morbidity rate (Table 4). There was a significant difference in morbidity rate between people working in agriculture and forestry and those in other occupations ($P < 0.001$).

Data on the local incidence of the disease are summarized in Table 5. Cases were reported in 66 out of 145 villages (45.5%) in the area investigated. Villages in the south-east of the area were more affected than those in the north-west, but there was no difference in the character of disease incidence between the two, most of the cases being sporadic.

TABLE 4
DISTRIBUTION OF VIRUS MENINGO-ENCEPHALITIS BY
OCCUPATION IN THE TRIBEČ AREA: 1960-63

Age-group (years)	Occupation	Incidence of virus meningo-encephalitis	
		No. of cases	Morbidity rate (per 100 000) ^a
0-4	Farmers and forestry workers Others	2	2.4
5-9		6	6.7
10-14		8	10.0
15-59		33	21.3
		15	4.5
60+		3	3.0

^a Rate is calculated per annum per 100 000 inhabitants in the relevant age or occupation group.

Serological examinations were made in 52 out of 67 cases reported in 1960-63. The results were positive in 47 cases.

The results of an epidemiological analysis of the mode of infection of 67 patients in the period 1960-63 are presented in Table 6; the most frequent method was by tick bite. The mode of infection was not elucidated in nine cases.

The clinical picture in these 67 cases was biphasic in 39 and monophasic in 25; in three patients the infection remained inapparent, though with a significant increase in the levels of complement-fixing and virus-neutralizing antibodies. Of the 64 patients with clinical symptoms, 28 were hospitalized on the basis of some other diagnosis, the most frequent diagnoses being serous meningitis and influenza; less frequent diagnoses included angina, pharyngitis and infections with echovirus or Group C arbovirus.

TABLE 5
DISTRIBUTION BY LOCALITY OF VIRUS MENINGO-ENCEPHALITIS
IN THE TRIBEČ AREA: 1953-63

Region	No. of villages in region	Villages with incidence of disease		Number of villages with				
		No.	%	1 case	2 cases	3-5 cases	6-10 cases	> 10 cases
South-East	78	46	58.9	20	6	7	6	7
North-West	67	20	29.8	7	4	3	3	3
Total	145	66	45.5	27	10	10	9	10

TABLE 6
MODE OF INFECTION OF 67 PATIENTS WITH TICK-BORNE
ENCEPHALITIS IN THE PERIOD 1960-63

Mode of infection	Number of patients					
	1960	1961	1962	1963	1960-63	
					No.	%
Tick	5	5	15	12	37	55.3
Goat's milk	0	0	6	0	6	8.9
Tick and goat's milk	2	1	7	5	15	22.3
Not elucidated	3	1	5	0	9	13.5
Total	10	7	33	17	67	100.0

In 1962, a virus-neutralization test was carried out on sera from 93 inhabitants of the villages of Dolné Štitáre, Jarok, Lapáš and Podhorany who in 1955-59 had suffered from an acute infection diagnosed as virus meningo-encephalitis. Antibodies against the tick-borne encephalitis virus were found in 63 of them (67.7%). Serological examination of 95 randomly selected inhabitants of the village of Bošany revealed no such antibodies.

DISCUSSION

The results of an epidemiological analysis have been presented in the form of statistical data on the morbidity rate for "virus meningo-encephalitis". The diagnosis of such an infection is based on

anamnesis and on the clinical picture, supplemented by routine clinical laboratory tests. The gradual introduction of serological and cultivation diagnosis of tick-borne encephalitis into the practice of Regional Sanitary-Epidemiological Stations, along with an epidemiological analysis carried out in the last five years, have made tick-borne encephalitis an accurately diagnosed entity, both during infection and immediately after. Previously, "virus meningo-encephalitis" was a heterogeneous complex, only some of the cases thus diagnosed actually being of tick-borne encephalitis. Evidence on this point is provided by a supplementary analysis of clinical meningo-encephalitis as presented in this study and in earlier work on another group of patients (Blaškovič & Karšai, 1962).

The present analysis of the morbidity rate for "virus meningo-encephalitis", which for the last five years can be considered to be very closely related to that for tick-borne encephalitis, revealed two peculiarities.

Firstly, years with a fairly high morbidity alternate with years with a lower morbidity. This alternation would become more obvious if the morbidity rates for "virus meningo-encephalitis" were studied over a longer period. So far, data from various parts of Czechoslovakia indicate that an increased morbidity rate occurred in 1948 (the year in which the virus was first isolated from a human patient; Gallia, Rampas & Hollender, 1949) and in 1951. However, in the latter year the increased incidence of infection was due to an explosive epidemic resulting from the consumption of infected non-pasteurized milk distributed by a dairy in a small town (Raška et al., 1954). This variation in incidence

is due to the variable distribution of the virus in nature, especially in vectors. A higher proportion of virus-bearing ticks in nature represents an increased danger of infection for man, who represents the last and blind link in the circulation of tick-borne encephalitis virus.¹

The second characteristic feature is the seasonal incidence of infection, with a major peak in May-June and in some years a minor peak in September. This feature also depends on the seasonal variation in the population of vectors and on the amount of virus circulating in nature.

A further characteristic of tick-borne encephalitis, especially when infection is by tick bite, is the age distribution of infection. Children less than 4 years old are only rarely taken into or near the woods; they do not graze goats, nor do they collect mushrooms or small fruit in the woods. Other children and, especially, men working in agriculture or forestry frequently enter habitats that are natural foci of tick-borne encephalitis.

The chance of primary and repeated infection increases, resulting in inapparent, moderate or clinically overt infections or in further immunization by new doses of virus, which ensures the persistence of antibody in the blood, with consequent immunity against reinfection.

All the characteristic features of the epidemiology of tick-borne encephalitis emphasize the overwhelming importance of the processes taking place in nature and which are reflected in the pattern of human infection. Recognition of this fact is vital in any attempt to conquer the disease.

¹ See the paper by Blaškovič, this Supplement, page 5.

RÉSUMÉ

Dans le cadre d'une enquête sur l'encéphalite transmise par les tiques dans la région de Tribeč, Tchécoslovaquie, les auteurs ont étudié l'aspect de la maladie chez l'homme qui représente le dernier terme dans la circulation du virus. Leur analyse a porté sur 445 cas diagnostiqués comme « méningo-encéphalite à virus » durant la période de 1953-1963.

Le taux moyen de morbidité a été de 19,3 par 100 000 habitants, variant de 107,9 en 1955 à 3,3 en 1961. Les taux les plus faibles ont été relevés dans les groupes d'âge de 0 à 4 ans (5,7) et de plus de 60 ans (5,5) et le taux le plus élevé dans le groupe d'âge de 10 à 14 ans (33,2). Pour la période 1960-1963, la morbidité la plus forte (21,3) a été observée chez les fermiers et les travailleurs

forestiers adultes. Les taux de morbidité dans la région de Tribeč ont atteint en moyenne 2,6 fois ceux de l'ensemble de la Tchécoslovaquie et 4,7 fois ceux de la Slovaquie. L'incidence a varié avec les saisons, présentant un maximum en juin.

Le mode d'infection le plus fréquent est par morsure de tiques mais, en 1951, une augmentation de l'incidence de l'infection a été due à la consommation de lait infecté non pasteurisé, distribué dans une petite ville. Dans les villages du sud-est de la région, l'incidence de la maladie a été plus élevée que dans les villages du nord-ouest. Les examens sérologiques ont révélé des variations d'activité à l'intérieur du foyer: dans quatre villages où des cas

de méningo-encéphalite à virus avaient été signalés, 63 habitants sur 93 (68%) possédaient des anticorps contre le virus de l'encéphalite transmise par les tiques alors qu'aucun des 95 habitants choisis au hasard

dans un village épargné par la maladie n'en possédait.

Le diagnostic immédiat et rétrospectif de l'affection a été rendu plus précis par l'utilisation de la sérologie et des méthodes de culture.

REFERENCES

- Blaškovič, D. & Karšai, L. (1962) [*Epidemiological situation in . . . Zlaté Moravce with respect to tick-borne encephalitis*]. In: Blaškovič, D., ed. [*The importance of immunization of domestic animals for a natural focus of tick-borne encephalitis*], Bratislava, Slovak Academy of Sciences, p. 38
- Ernek, E. & Škoda, R. (1958) *Biologia (Bratislava)*, **13**, 481
- Gallia, F., Rampas, J. & Hollender, L. (1949) *Čas lék. čes.*, **88**, 224
- Raška, K. et al. (1954) [*Epidemiology of Rožňava encephalitis*]. In: Blaškovič, D., ed. [*The epidemic of encephalitis in Rožňava natural focus of infection*], Bratislava, Slovak Academy of Sciences, p. 314
-

Transliteration from Cyrillic characters

The "International System for the Transliteration of Cyrillic Characters", set out in Recommendation ISO/R9-1954 (E) of the International Organization for Standardization, is normally used in the *Bulletin of the World Health Organization* for personal names, titles of publications, etc. However, papers accepted for publication may contain names transliterated differently, and if the original Cyrillic spelling is not recognizable inconsistencies may occur.

For convenience the transliteration from Russian according to ISO/R9 is given below:

Translittération des Caractères cyrilliques

Le « Système international pour la translittération des caractères cyrilliques » présenté dans la Recommandation ISO/R9-1954 (F) de l'Organisation internationale de Normalisation est généralement utilisé dans le *Bulletin de l'Organisation mondiale de la Santé* pour les noms de personnes, les titres de publications, etc. Cependant des articles acceptés pour publication peuvent contenir des noms translittérés différemment et si l'orthographe cyrillique originale n'est pas reconnaissable un manque d'uniformité peut s'ensuivre.

A toutes fins utiles, la translittération du russe selon la recommandation ISO/R9 est indiquée ci-après:

Cyrillic character Caractère cyrillique	Trans- literation from Russian Trans- littération du russe	Examples and remarks Exemples et observations	Cyrillic character Caractère cyrillique	Trans- literation from Russian Trans- littération du russe	Examples and remarks Exemples et observations
А, а	a	Адрес = Adres	У, у	u	Утро = Utro
Б, б	b	Баба = Baba	Ф, ф	f	Физика = Fizika
В, в	v	Вы = Vy	Х, х	h	Химический = Himičeskij
Г, г	g	Глава = Glava	Ц, ц	c	Центральный = Central'nyj
		Голова = Golova	Ч, ч	č	Часы = Časy
Д, д	d	Да = Da	Ш, ш	š	Школа = Škola
Е, е (ё) ¹	e (ë)	Ещё = Eščë	Щ, щ	šč	Щека = Ščeka
Ж, ж	ž	Журнал = Žurnal	(medial, médial)	"or" "ou"	In modern Russian, where ' sometimes replaces medial ъ, transliteration is still ". En russe moderne, où le ' remplace quelquefois le ъ médial, la translittération reste ".
З, з	z	Звезда = Zvezda			
И, и	i	Или = Ili			
Й, й	j	-ый, -ий, -ой = -yj, -ij, -oj			
К, к	k	Как = Kak			
Л, л	l	Любить = Ljubit'			
М, м	m	Муж = Muž			
Н, н	n	Нижний = Nižnij			
О, о	o	Общество = Obščestvo	(final)	(Not transliterated. Non translittéré.)	
П, п	p	Первый = Pervyj	Ы, ы	y	Был = Byl
Р, р	r	Рыба = Ryba	Ь, ь	'or' 'ou'	Маленький = Malen'kij
С, с	s	Сестра = Sestra	Э, э	ě	Это = Ěto
Т, т	t	Товарищ = Tovarišč	Ю, ю	ju	Южный = Južnyj
			Я, я	ja	Яйцо = Jajco

¹ Cyrillic ë to be transliterated by ë only when the diacritical appears in the original. Le ë cyrillique ne doit être translittéré par ë que lorsque la diacritique apparaît dans l'original.