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Tick-Borne Encephalitis – epidemiological analysis of case count and prevention from 2007-2017

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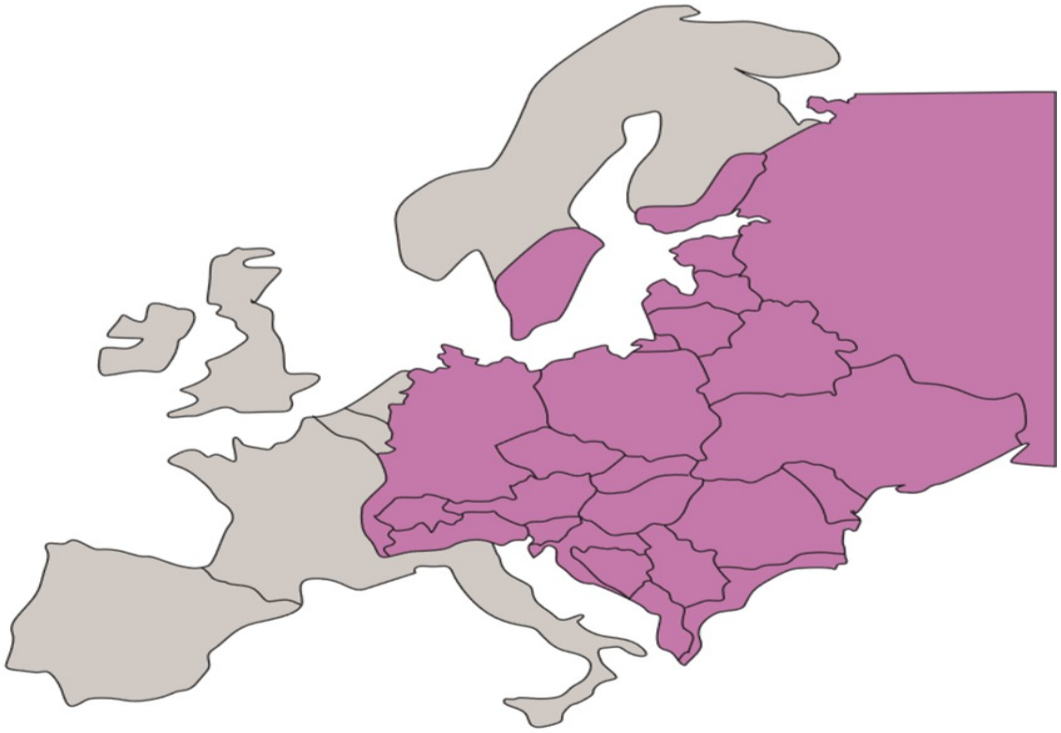
Summary

The following article presents the epidemiological situation in Poland over the 2007-2017 period. The article is based on the analysis of "Contagious diseases and toxoinfections in Poland" and "Vaccination in Poland" surveys and pamphlets from the State Department of Hygiene. Supplementary information concern infection by the virus, clinical manifestation, detection, diagnostic procedure and vaccination against TBE virus. The results were developed using a descriptive method.

Key words: tick-borne encephalitis, *Ixodes ricinus*, ticks, epidemiology, vaccination, prevention, prophylaxis, tick-borne encephalitis virus.

Introduction

Tick-borne encephalitis (TBE) is a viral infectious disease involving the central nervous system. TBE is caused by tick-borne encephalitis virus (TBEV), member of the genus *Flavivirus* in the family *Flaviviridae*. TBEV is transmitted by the bite of several species of woodland ticks infected by the virus, including *Ixoides scapularis, Ixoides ricinus* and *Ixoides persulcatus*, it is rarely transmitted by drinking non-pasteurized milk of an infected cow. The virus causes a wide spectrum of infections, including: meningitis, meningoencephalitis, encephalitis, encephalomyelitis and poliomyelitis-like disease [1, 24]. TBEV is endemic in the regions of central, eastern and northern Europe, stretching east through Russia, through Siberia all the way to China [pict. 1]. In 2009, Sweden had the highest reported TBE morbidity of Scandinavian countries [2]. In some parts of Europe, for ex. in Czech Republic, the occurrence of TBEV has been rising since the 70s, which is partly due to climate change and global warming [19, 20]. Tracking the dynamic of the virus and new outbreaks calls for regular data actualization in order to ensure the safety of the population and the people visiting the endemic regions. The understanding of the life cycle of the virustransmitting tick species and their natural hosts, as well as the susceptibility to infection of human population in regard to the season and climate, are key factors in preventing tick-borne diseases [11, 18]. In most European countries TBE belongs to the group of (obligatory) notifiable diseases. However the definition and report procedures vary across the endemic region. In Poland the criteria for reporting a TBE case consist of the occurrence of neurological symptoms and stating the diagnosis based on laboratory test results including: the presence of specific IgM and IgG (in plasma, CSF) or confirmed synthesis of specific antibodies or a positive outcome of FAVN test (fluorescent antibody virus neutralization test) (confirmed case) or the presence of specific IgM in plasma (patients unvaccinated to TBE and/or other flaviviruses) (highly probable case) [24]. There is no effective treatment against TBEV. The only effective method of prevention is TBE vaccination [3]. The podlaskie voivodship is the region with the highest risk of TBEV infection in Poland. Currently, there are 4 anti-TBEV vaccine types available in Poland.



Picture 1. Map of endemic regions for TBE in Europe (ares where TBE virus has been detected)

Epidemiology

TBE is a zoonosis caused by viruses transmitted by ticks. In Poland over the 2007-2017 period, TBE accounted for 56% of all cases of encephalitis caused by viral infections [fig. 1]. Other causes of viral encephalitis include infections by: HSV-1, EBV, VZV, flu virus, rubella, mumps and measles viruses. The epidemiology of tick-borne encephalitis includes aspects such as age, geographic latitude, landscape, agricultural activity, migration, climate change, political changes and the abundance of host organisms [11, 17]. In the cited literature, there is no mention of the possibility of transmission of TBE from the mother to the foetus via placenta. A PubMed article describes a case of a woman in 37th week of gestation/pregnancy being infected by TBEV. The patient developed meningoencephalitis without permanent neurological damage. The woman gave birth to a healthy offspring in 40th week of gestation. The baby was tested for anti-TBE virus antibodies in both IgG and IgM in the 30th month of life, both results were negative. Future test results came back negative confirming that the baby has not been infected during pregnancy [1].

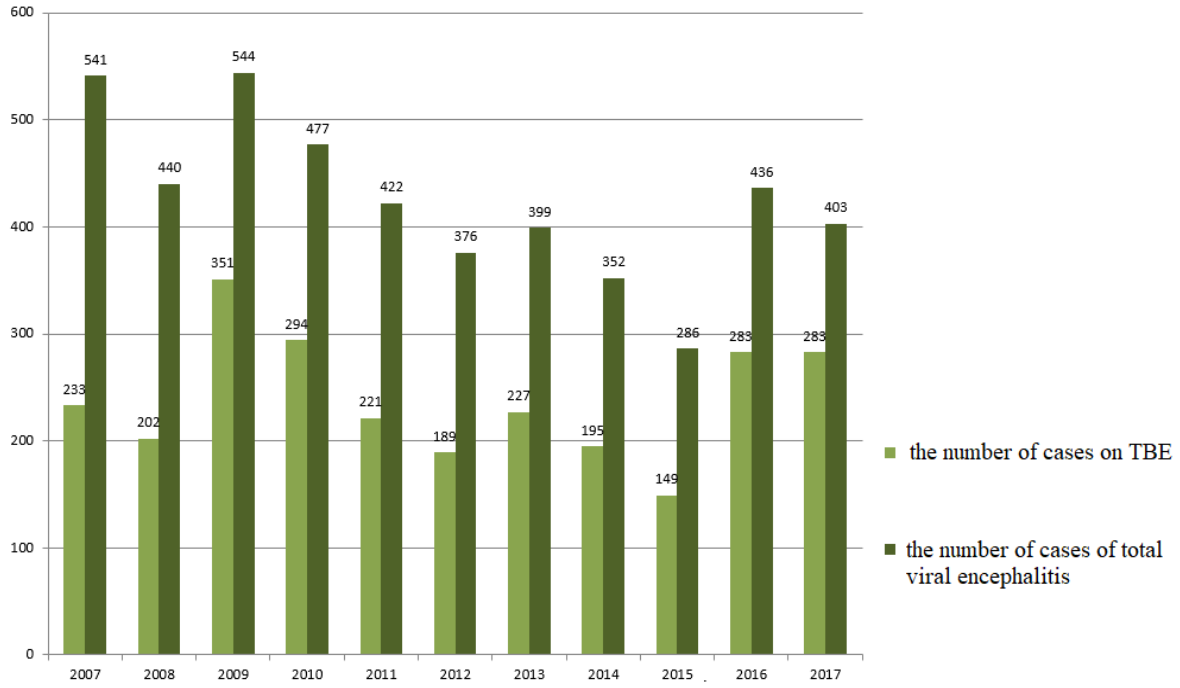


Figure 1. TBE cases in comparison to all viral encephalitis in 2007- 2017 in Poland

The most investigated and best known endemic focus of TBEV in Poland is the forest of Białowieża which remains an active focus of TBEV. Large TBEV morbidity rate of that region is due to the extensive forests which provide a good/excellent environment for the infected ticks [fig. 2]. Over the 2007-2017 period the TBE cases reported from podlaskie voivodship accounted for 48% of total cases in Poland.

Multiple species of ticks are capable of transmitting TBE virus, however the species playing the main role in virus transmission are Ixodes ricinus in Europe and *Iodes persulcatus* and *Haemophysalis concinna* in Russia [4]. Ticks from the Ixodes genus have a three-host life cycle involving developmental stages of egg, larvae, nimf and adult form. Their full lifecycle takes 2-4 years to complete. Through every stage of life, the ticks need blood for further development. There are multiple stimuli such as: temperature and the smell of lactic acid (present in sweat), informing the tick of a potential host nearby [23]. In order to survive the ticks need at least 80% relative air-humidity. This leads to believe that air humidity is the fundamental condition for the ticks to survive and the primary factor limiting the search time a tick can spend on finding a host organism. The rise of air temperature plays just as big of a role in the increase of morbidity rate in tick-transmitted diseases [21, 22].

The ticks' saliva contains desensitising substances which makes the ticks bite undetectable. Typical loci for tick bites are the skin covering the head, ears, large joints, upper and lower extremities [5].

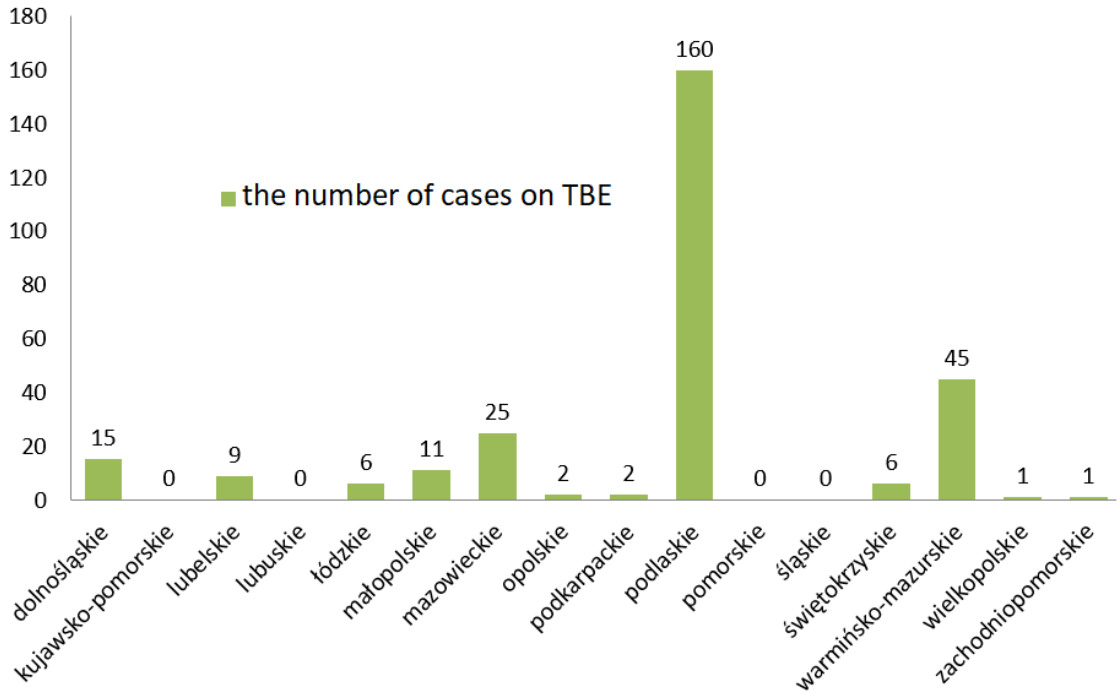


Figure 2. The number of cases on TBE in Poland in 2017 by voivodships

According to the data from the National Institute of Public Health – State Department of Health, the number of new cases of TBE virus infections in Poland closely correlates with the seasonal activity of the ticks [fig.3]. Most infections in Poland occur between April and November, where two peak morbidity rates can be identified: the summer peak (June, July) and the autumn peak (September, October) [6].

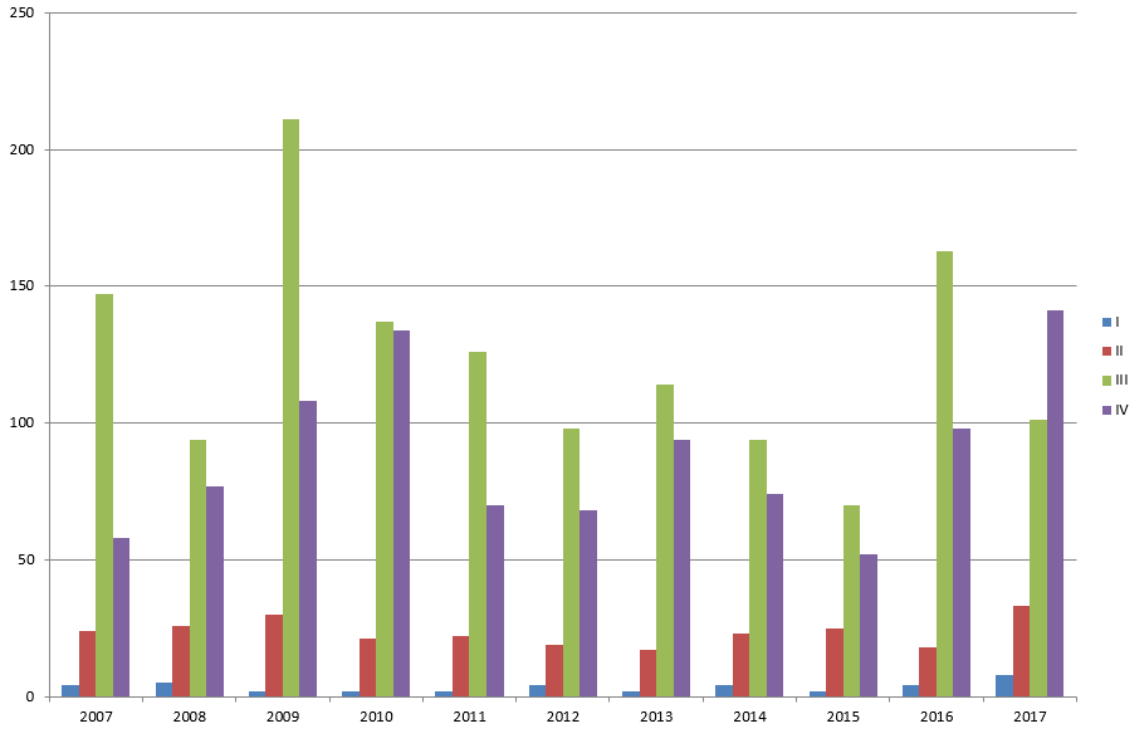


Figure 3. The number of cases in particular quarters of 2007-2017

In 2007 there were 233 reported cases of TBEV infections in Poland, in 2017 the number of cases increased to 23. The highest number of cases has been reported in 2009 counting 351 cases, the lowest number of cases was reached in 2015 with 149 reported infections. Based on the statistics mentioned above, a conclusion can be drawn that the number of reported TBE cases has been fluctuating over the 2007-2017 period, furthermore over 2015/2016 period the number of cases has almost doubled [fig. 4]. All reported cases of TBE in Poland were hospitalized [6].

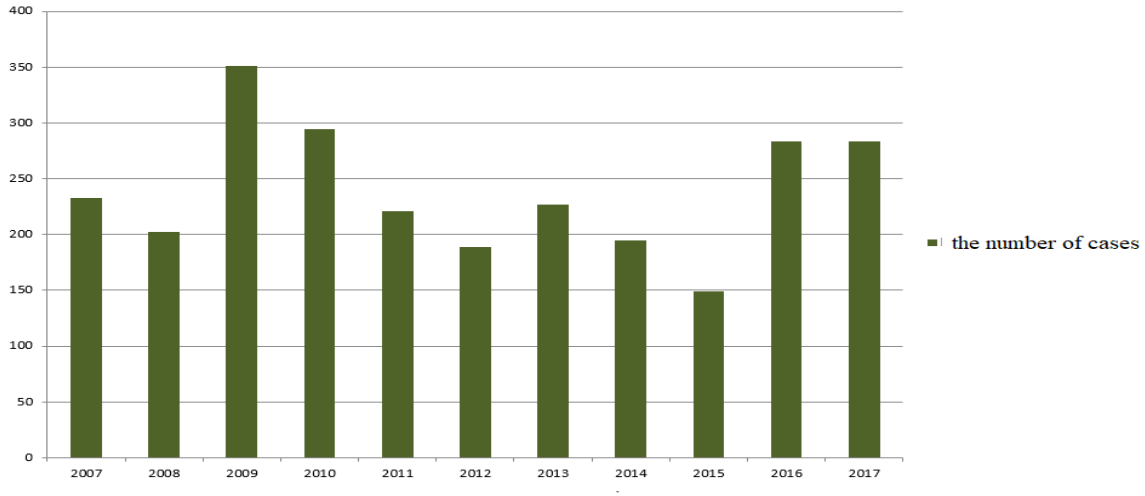


Figure 4. The number of cases of TBE in Poland in 2007-2017

The rise of morbidity rates of TBE since the 90s in Poland has been a topic of discussion for the recent years. Multiple reasons have been identified. Currently, the factors thought to be had the most influence on the rising morbidity rate are: the climate change having a positive effect of the conditions in areas inhabited by the ticks, constant improvement of the infection reporting system and detection methods of TBE virus, increased recreational activity of human population in areas inhabited by infected ticks [7, 24]. 2/3 of TBEV infections in human population are subclinical or present no symptoms on examination, this suggests that not all cases have been reported and the number of total cases is larger than the number of reported cases. This makes the risk of infection by TBEV in the human population difficult to estimate [23, 25].

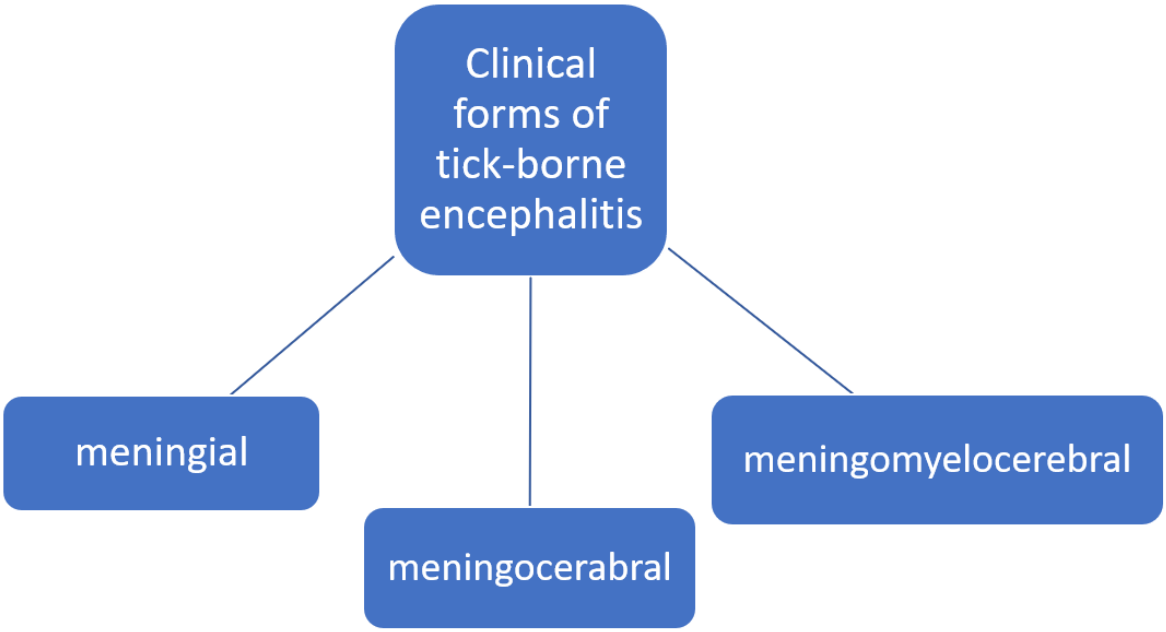
Clinical manifestation of TBE

The risk of developing TBE from the bite of a tick in a patient in central Europe, who has no specific immunity to TBEV, ranges between 0,003% and 0,75%. In the majority of cases, an infection by TBEV presents little to no symptoms. The clinical appearance of TBE and the intensity of its course depends on the species of pathogen [12, 18]. After the TBE virus has entered the hosts, it spreads mainly by the lymphatic system but may be distributed by the circulatory system as well. The disease typically follows a biphasic pattern. The first phase lasts 1-8 days after tick bite, in which time the virus replicates (incubation period ranges from 4 to 28 days). First symptoms of mild fever, nausea, headache, vomiting and myalgias emerge quickly. During this period, laboratory test may present leukopenia, thrombocytopenia and a rise in albumin concentration in CSF. In 13-26% of cases the disease ends in the first phase, rest of patients enter the second phase – neurological phase. The second phase includes fevers up to 40°C, headaches, nauseas, vomiting, myalgia and meningeal symptoms. There are 4 subtypes of TBE [4,8]:

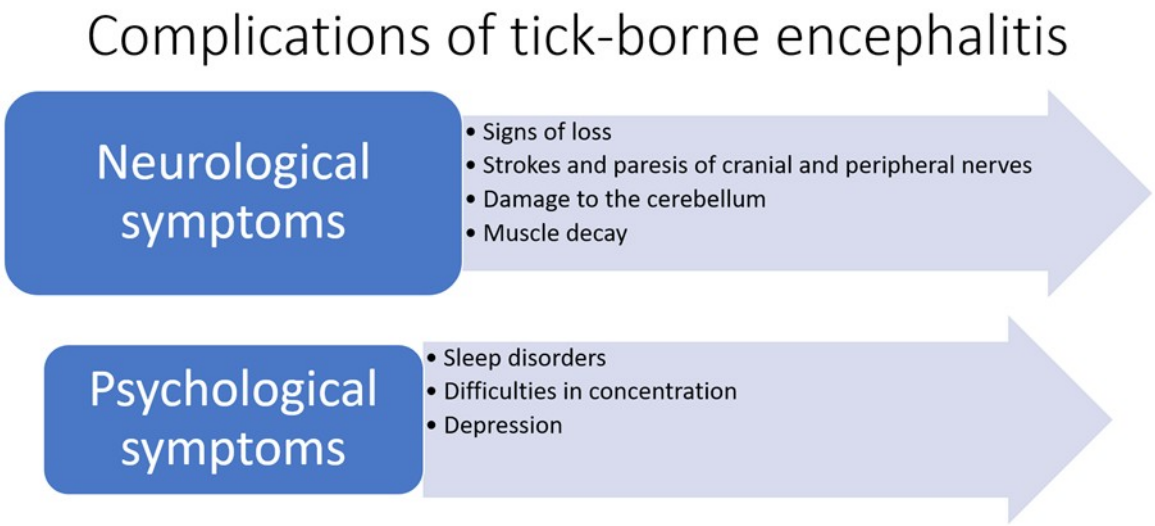
- Meningial – the most benign and common subtype of TBE
- Meningocerabral – more severe subtype accompanied by symptoms/features of encephalitis
- Meningomyelocerebral – most severe subtype with symptoms of destruction of the anterior spines of spinal cord, 10% of cases

Meningoencephalitis accompanied by meningeal symptoms

TBE mortality in Poland is 5%.



Most of the complications from TBE are neurological defects (35-59% of patients), some of which include: muscular atrophy of the shoulder girdle, symptoms suggesting damage to the cerebellum, cholinergic-mediated cognitive deficits, peripheral and/or facial nerve paresis or palsy. Some cognitive defects resulting from TBE complications include loss of consciousness, sleep disorders, concentration disorders and depression [13].



A case report

A case report found on the PubMed database describes the case of a 65 year old male, who after being bit by a tick was diagnosed with TBE based on presented symptoms and laboratory test results. The patient suffered from headaches and disorientation which later progressed to motor

ataxia and dyspraxia accompanied by fever and nuchal rigidity. The symptoms were alleviated, however three weeks later the patient developed symmetrical facial palsy, motor palsy of the upper right and the lower left extremity (muscular reflexes remained intact). CSF was tested again and an MRI scan was conducted. The results revealed pathological demyelization of both motor neurons and sensory neurons. Based on further examination, the patient was diagnosed with Guillain-Barre syndrome. The patient was treated with IVIG and early rehabilitation was started, which lead to a gradual improvement of the patients condition [14]. This case presents symmetrical facial paralysis where muscular reflexes remained intact which are features that have inducted into the diagnostic criteria for GBS [15]. Based on this example TBEV is in the group of flaviviruses capable of inducing Guillain-Barre syndrome.

Diagnosis and clinical procedure in TBE

In case of a suspicion of CNS infection by TBEV, a lumbar puncture needs to be performed for a pathomorphological assessment of the amount and quality of CSF, unless there are clear contraindictions for the procedure. The most important contraindiction is the risk of cerebral herniation, leading to the compression of vital areas of the brainstem and abrupt death. Other important contraindictions include infected tissues in near proximity of the puncture, blood clotting disorders, lack of patients compliance and critical condition of the patient. Brain imaging procedures lack sensitivity and specificity in diagnosing TBE however they are useful in differential diagnosis of disorders with similar manifestations [10].

In case of cerebral oedema, increasing analgosedation is recommended. Osmotherapy and corticosteroids are not recommended. In case the internal cranial pressure (ICP) continues to rise, therapeutic hypothermia (lowering the patient's body temperature to 32-34°C) should be considered in order to prevent neurological damage. If epileptic seizures occur, they should be treated as other symptomatic epileptic bouts.

Vaccination

There are 4 anti-TBEV vaccines available in Poland: FSME-Immun 0,5 ml, FSME-Immun 0,25 ml Junior, Encepur Adults, Encepur K. In the Polish Vaccination Program, since 2005, vaccination against TBEV is a recommended vaccination, not financed by the Ministry of Health budget. The vaccines are administered according to the dosage and cycle recommended by the manufacturer of the vaccine. A correctly administered vaccination cycle induces permanent resistance to TBEV in 98% of vaccinated population [9]. Some children don't finish the vaccination

cycle. This is mainly due to the parents negligence and incomprehension of potential harm. The parents awareness of the necessity of completing the vaccination cycle has to be improved because only the completed vaccination cycle allows for a full and permanent resistance to TBE [12]. It should be noted that vaccination against TBEV does not grant resistance to borreliosis. State Hygiene Institute data analysis has shown an increasing interest in vaccination against TBE during the 2014-2017 period [fig. 5]. Largest number of anti-TBEV vaccinations has been registered in 2009 and the lowest number was reached in 2014 [6]. Despite the growing number of vaccinated population in Poland, the number of cases remains high. The frequency of registered TBE cases in Europe is constantly on the rise largely due to the spreading of the endemic region and the prolongation of the annual period when the ticks remain active. This increase in TBE morbidity poses a growing health risk to people within the endemic region [10]. In order to decrease the annual number of registered cases and increase the number of vaccinated citizens, it is necessary to educate the general public on the risk TBE poses and necessary prevention procedures.

Vaccination against TBE is recommended to all age groups older than 12 months of age for people inhabiting endemic regions (≥5 cases/100 000 citizens/year) and to the population more susceptible to TBEV infection living in non-risk areas. Individuals traveling to endemic regions should be vaccinated if their visit will include outdoor recreational activity in green areas where the risk of tick bite is heightened. Post expository prevention after tick bite is not recommended.

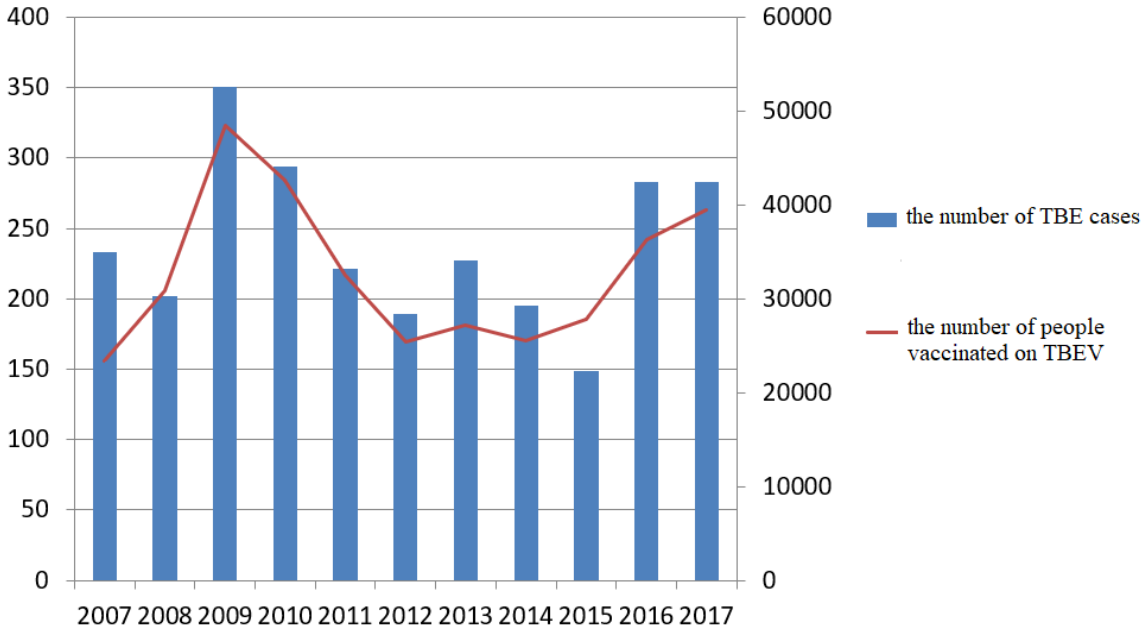


Figure 5. The number of cases and the number of vaccinations

Summary

Tick-borne encephalitis (TBE) is a serious disease of the central nervous system that can occur in many clinical forms. In Poland, TBE is the main cause of brain inflammation of viral etiology. The diseases are characterized by seasonality and occur mainly in the spring and summer. The highest number of cases occurred in 2010, and the lowest in 2015. In 2015/2016, the number of cases with TBE increased almost twice. It was at the same level in 2017. Every year the highest number of TBE cases is recorded in the region Podlasie and it accounts for about 80% of cases of TBE in Poland. There is no causative treatment of TBE, the only form of prevention of the disease are protective vaccinations, which in Poland are recommended for specific groups of people. Analysis of TBE vaccination data has shown a gradual increase in the interest in TBE protective vaccinations from 2014 to 2017. Despite the growing number of people vaccinated against TBE in Poland, the number of cases remains high. The society in TBE prophylaxis should be educated.

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