POKORA, Szymon, POKORA, Karolina, POLOCZEK, Alicja and SZCZERBA, Jakub. Autoimmune Limbic Encephalitis – literature review. Journal of Education, Health and Sport. 2024;56:83-96. eISSN 2391-8306.
https://dx.doi.org/10.12775/JEHS.2024.56.006
https://apcz.umk.pl/JEHS/article/view/47973
https://zenodo.org/records/10607941

The journal has had 40 points in Minister of Science and Higher Education of Poland parametric evaluation. Annex to the announcement of the Minister of Education and Science of 05.01.2024 No. 32318. Has a Journal's Unique Identifier: 201159. Scientific disciplines assigned: Physical culture sciences (Field of medical and health sciences); Health Sciences (Field of medical and health sciences).
Punkty Ministerialne 40 punktów. Załącznik do komunikatu Ministra Nauki i Szkolnictwa Wyższego z dnia 05.01.2024 Lp. 32318. Posiada Unikatowy Identyfikator Czasopisma: 201159. Przypisane dyscypliny naukowe: Nauki o kulturze fizycznej (Dziedzina nauk medycznych i nauk o zdrowiu); Nauki o zdrowiu (Dziedzina nauk medycznych i nauk o zdrowiu).© The Authors 2024;
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The authors declare that there is no conflict of interests regarding the publication of this paper.
Received: 10.01.2024. Revised: 27.01.2024. Accepted: 02.02.2024. Published: 02.02.2024.

Autoimmune Limbic Encephalitis – literature review

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Abstract: Autoimmune Limbic Encephalitis is a rare disease occurring with a frequency of approximately 13.7/100,000 people, mainly among middle-aged women. The disease is caused by autoantibodies, either synthesised due to the presence of a tumour or having an idiopathic nature. Depending on the type of autoantibodies detected, the disease is divided into subtypes, which differ in the frequency of specific clinical symptoms (most commonly psychosis, mood changes, memory problems, cognitive impairment and seizures) and can direct to detection of a specific type of cancer. Making a prompt diagnosis and initiating treatment is crucial as it ensures a reduction in clinical symptoms and improves survival rate. Broad immunotherapy is used - intravenous immunoglobulin, corticosteroids, azathioprine, rituximab, cyclophosphamide, anti-epileptic drugs and plasmapheresis. The efficacy is high - 80% of patients recover, and relapses occur in only 10% of cases. If a patient is diagnosed with cancer, effective oncological treatment is necessary to achieve complete remission.

Materials and methods: In order to select articles, the literature available in PubMed and Google Scholar was reviewed, using the keywords: autoimmune limbic encephalitis, autoantibodies, immunotherapy. From the available papers, those from 2000-2023 that best described the topic were selected. Among the selected articles, retrospective descriptions, clinical cases and descriptive articles were taken into account. This paper describes the epidemiology, pathophysiology, clinical manifestations, diagnosis and treatment of the disease.

Keywords: autoimmune limbic encephalitis, autoantibodies, immunotherapy

Introduction:

Autoimmune Limbic Encephalitis (ALE) is the most common subtype of autoimmune encephalitis, first described in 1968 (Corsellis et al.) [1]. It is caused by the presence of autoantibodies that induce inflammation in the medial parts of the temporal lobes, but inflammation can spread to other parts of the brain at a later stage of the disease [1]. Initially, the disease was seen only as a paraneoplastic syndrome, but its non-neoplastic forms have also been proven. Because of its nonspecific neuropsychiatric symptoms, which fit a wide spectrum of disorders, making a diagnosis is sometimes problematic, and the average time from onset of symptoms to diagnosis is 4 weeks (2 to 104 weeks) [2]. The prevalence of ALE is estimated at 13.7/100,000 people and is more common among African-Americans than Caucasians, while the incidence is 0.8/100,000 per year [3]. It is most common in middle-aged people, but also affects children and the elderly [4]. The increase in the detection of ALE in recent years is related to more effective detection of the autoantibodies that cause the disease. This is important because early detection and implementation of therapy significantly improves treatment outcomes.

Pathophysiology

The pathophysiology of ALE is related to the production of autoantibodies by the patient's immune system against antigens located on cells of the limbic

system. The inflammation most often involves the hippocampus, the cingulate nerve, the medial part of the temporal cortex and the orbitofrontal cortex [5]. For a long time it was thought that ALE was a paraneoplastic syndrome and that the synthesis of autoantibodies was caused by the presence of a malignant tumor, but later forms of ALE unrelated to cancer were also proven [6]. The latter type of disease most often affects young women [7]. Based on the type of autoantibodies detected, ALE is divided into types, which differ in the presenting symptoms, rate of disease progression and response to treatment. Antibodies that attack intracellular antigens are more often associated with malignancy, and are therefore sometimes called "onconeuronal" [8]. In contrast, the presence of antibodies against extracellular antigens less often correlates

with the presence of cancer. ALEs can cause the following types of antibodies [9]:

Intracellular antibodies:

Anti-GAD (glutamic acid decarboxylase)-antibodies are associated in 25% of cases with malignancy, mainly with thymoma and small cell lung cancer.

- Anti-Hu antibodies (also known as ANNA-1 - antineuronal nuclear antibody-type 1)-are associated in more than 90% with small-cell lung cancer in adults, and with neuroblastoma in children.

- Anti-Ma2- antibodies associated with testicular cancer in more than 90%.

- Antibodies to amphiphysin (protein responsible for follicular endocytosis)-associated with small cell lung cancer and breast cancer in more than 90%.

- Anti-CRMP5 (collapsin response-mediator protein-5)-associated with thymoma and small cell lung cancer in more than 90%.

- Anti-AK5 (adenylate kinase 5)-antibody not associated with a specific cancer type.

Extracellular antibodies:

Anti-LGI-1 (leucine-rich glioma inactivated 1)-antibodies are the most common type of antibody causing ALE, and are associated in 10% with various types of cancer (thyroid, breast, pancreas, colorectal, thymoma).

- Anti-CASPR2 (contactin-associated protein-like 2)-antibodies are associated in 20% with thymoma, especially with coexisting peripheral nerve hyperactivity.

- Anti-GABABR (γ-aminobutyric acid B receptor)-antibodies-associated in 50% with small-cell lung cancer.

- Anti-AMPAR (α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid receptor)-antibodies are 60% associated with small cell lung cancer and thymoma.

- Anti-NMDAR (N-methyl-d-aspartate receptor)-antibodies-associated in 40% with ovarian monomas, mainly in women between 12 and 45 years of age.

- Anti-MGluR5 (metabotropic glutamate receptor 5)- antibodies-associated in 50% with Hodgkin's lymphoma.

- Antibodies to Neurexin-3-alpha-not associated with a specific type of cancer

Symptoms

Inflammation of the limbic system causes nonspecific neuropsychiatric symptoms, such as psychosis, diurnal rhythm disturbance, mood changes, memory problems, cognitive impairment and seizures [1]. Damage to the hypothalamus causes an increase or decrease in appetite and libido, the amygdala increases aggression and emotion, and inflammation within the hippocampus manifests itself through memory and concentration deficits [10]. Symptoms of the disease can vary, depending on its subtype, caused by specific types of autoantibodies:

• ALE with anti-NMDA antibodies - is the best known subtype of the disease. It usually begins with prodromal symptoms such as fever, headache and malaise.

Then, neuropsychiatric symptoms appear [11] - agitation and disorientation, which may progress to psychosis, convulsions and autonomic instability, which in extreme cases requires treatment in an intensive care unit [12].

• BUT with anti-mGluR5 antibodies - causes neuropsychiatric symptoms and cerebellar syndrome, and sometimes leads to cerebellar atrophy. Approximately 91% of patients have mental and/or cognitive deficits, 64% have sleep disorders, 55% have epileptic seizures, sometimes progressing to status epilepticus, and 45% have movement disorders such as clonus or dyskinesia [13].

• ALE with anti-AMPAR antibodies- is a very rare and therefore poorly studied subtype. The most common symptoms are confusion (49%), amnesia (52%), seizures (29%) and psychiatric symptoms (47%) [14].

• BUT with anti-LGI-1 antibodies - the symptoms are confusion and amnesia (almost 100%) and seizures (92%), and other common symptoms are hyponatremia (59%) and movement and sleep disorders [15]. The occurring seizures may have characteristic paroxysmal activity, described as short, dystonic, affecting the arm and face on the same side, called faciobrachial dystonic seizures [16].

• BUT with anti-CASPR2 antibodies - it is characterized by slow progression of symptoms and affects more often men. The most common symptoms are cognitive disorders (26%), seizures (24%), hyperexcitability of peripheral nerves (13%) and neuropathic pain [17].

• BUT with anti-GABABR antibodies - most often affects middle-aged and older men. It is characterized by sudden onset of symptoms such as behavioral changes (97%), seizures (90%), refractory status epilepticus (42%), and rapidly progressive dementia. They may be preceded by flu-like prodromal symptoms [18].

• BUT with anti-GAD antibodies - common symptoms are seizures (97%), memory impairment (59%), cognitive impairment (40%), psychiatric symptoms, mainly depression or personality changes (28%), and epileptic (24%) [19]. A characteristic symptom of this disease is Stiff-person syndrome.

• BUT with anti-Hu antibodies - symptoms are most often associated with the sensory system (54%), motor system (45%), brain stem (31%), autonomic system (28%), cerebellum (25%) and limbic system (22%) [20]. In 70%-78% of patients, neurological symptoms affect more than one system [21].

• BUT with anti-Ma2 antibodies - clinical symptoms result from involvement of the limbic system, hypothalamus and brainstem by the disease process. Patients experience daytime sleepiness, narcolepsy, cataplexy, hyperphagia, hypokinesia and dystonia, which may interfere with speech and eating [22]. These symptoms may be confused with Whipple's disease, as evidenced by the fact that 16% of patients underwent duodenal biopsy before being diagnosed with the paraneoplastic syndrome [23].

• BUT with anti-CRMP5 antibodies - the disease affects the cerebellum and the sensorimotor system, manifesting as cerebellar ataxia, uveitis, optic neuritis, with the possibility of progression to encephalomyelitis [24].

Diagnostics

Diagnosing ALE is often problematic because the symptoms are very non-specific and often suggest another disease. Up to 2/3 of patients are initially misdiagnosed, mostly psychiatric diseases, neurodegenerative diseases and epilepsy [25]. However, when limbic encephalitis was already diagnosed, in 1/3 of cases it was incorrectly assumed to be infectious rather than autoimmune, which proves that the prodromal symptom of fever should not suggest an infectious cause [26]. Importantly, the detection of autoantibodies, especially those strongly associated with the occurrence of cancer, may accelerate the initiation of oncological diagnosis and treatment. ALE precedes the diagnosis of cancer in 60% of cases by an average of 3.5 months [21]. ALE is diagnosed in the following ways:

• Imaging methods: Magnetic resonance imaging may show changes typical of ALE in the medial part of the temporal lobes. However, it should be borne in mind that many disease entities can also affect these areas of the brain, including: herpes viruses

and VZV [28], gliomas [29], stroke [30], and even epilepsy during a seizure [31]. There are also reports that Positron Emission Tomography (18-FDG-PET) may be a more sensitive method for detecting ALE , however, it is not currently widely used [32].

• Electroencephalography (EEG): EEG may show signs of inflammation in the temporal lobe area, such as slow waves and epileptiform discharges. These changes, even when the MRI image is normal, allow us to suspect ALE and should prompt further diagnostics and repeat MRI in order to assess the possible progression of changes over time [33]. However, in some patients with ALE, the EEG examination may be normal [34].

• Cerebrospinal fluid analysis: may confirm the inflammatory process taking place in the central nervous system. However, the sensitivity of this method is not high - leukocyte pleocytosis and the presence of oligoclonal bands are found in approximately 25% of patients with ALE [35]. This is a good method for differentiating from other diseases that also cause inflammation in the CNS, e.g. detection of herpes virus infection by PCR [36].

• Determining the level of autoantibodies: It is a very important method in detecting ALE. It allows determining the subtype of the disease and may guide appropriate oncological diagnostics - approximately 60% of patients with onconeuronal autoantibodies were diagnosed with a malignant tumor [21]. The level of autoantibodies should be determined both in the cerebrospinal fluid and in blood serum, because some autoantibodies are more likely to be detected in serum (e.g. anti-LGI-1) [37] and others only in the cerebrospinal fluid (e.g. anti-LGI-1). GABABR) [38]. It should also be remembered that in 2 out of 100,000 cases of ALE, no type of antibody is detected [3].

• Graus criteria [5]: may be helpful to make a confident diagnosis of ALE. All of the following criteria must be met:

o Subacute onset (less than 3 months) of symptoms suggestive of limbic system involvement, such as memory impairment, seizures, or psychiatric disturbances.

o Bilateral abnormalities limited to the medial parts of the temporal lobes, visible on T2 and FLAIR magnetic resonance imaging.

o Detection of pleocytosis (>5 leukocytes/mm3) in the cerebrospinal fluid or EEG showing slow waves or paroxysmal discharges in the temporal lobes.

o Exclusion of other potential causes of symptoms using appropriate methods.

If any of the first 3 criteria are not met, one of the types of autoantibodies responsible for the disease must be detected to make a confident diagnosis of ALE.

Treatment

Quick diagnosis of the disease and initiation of treatment is very important because it leads to a reduction in the frequency of epileptic seizures, improvement of cognitive functions and survival [27]. A wide range of immunotherapy is used - intravenous immunoglobulins, corticosteroids (e.g. methylprednisolone), azathioprine, rituximab, cyclophosphamide, antiepileptic drugs and plasmapheresis [1]. If the first line of immunotherapy did not bring the desired results, the second line usually gives good results [12]. Currently, there is no evidence that the response to treatment differs depending on the type of autoantibodies detected [39]. The effectiveness is quite high - about 80% of patients recover, and relapses occur only in 10% of cases [40]. If a patient is diagnosed with cancer, effective oncological treatment is necessary to achieve full remission of ALE.

Summary

Autoimmune encephalitis is a relatively rare disease with non-specific symptoms, so correct diagnosis can be problematic. When diagnosing ALE, it is also important to determine the type of autoantibodies present, as this may lead to the search for a specific type of cancer. Quick implementation of treatment j

Author Contributions

All authors contributed to the conceptualization, formal analysis, research, methodology, writ-ing and editing of the original draft and read and agreed to the published version of the manu-script.

Funding

This research did not receive any external funding.

Statement of institutional review board

Not applicable.

Statement of informed consent

Not applicable.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or fi-nancial relationships that could be construed as a potential conflict of interest

References

1. Tüzün E, Dalmau J. Limbic encephalitis and variants: classification, diagnosis and treatment. *Neurologist*. 2007;13(5):261-271. doi:10.1097/NRL.0b013e31813e34a5
2. Höftberger R, Titulaer MJ, Sabater L, et al. Encephalitis and GABAB receptor antibodies: novel findings in a new case series of 20 patients. *Neurology*. 2013;81(17):1500-1506. doi:10.1212/WNL.0b013e3182a9585f
3. Dubey D, Pittock SJ, Kelly CR, et al. Autoimmune encephalitis epidemiology and a comparison to infectious encephalitis. *Ann Neurol*. 2018;83(1):166-177. doi:10.1002/ana.25131
4. Honnorat J, Didelot A, Karantoni E, et al. Autoimmune limbic encephalopathy and anti-Hu antibodies in children without

cancer. *Neurology*. 2013;80(24):2226-2232. doi:10.1212/WNL.0b013e318296e9c3

5. Graus F, Titulaer MJ, Balu R, et al. A clinical approach to diagnosis of autoimmune encephalitis. *Lancet Neurol*. 2016;15(4):391-404. doi:10.1016/S1474-4422(15)00401-9
6. Schermann H, Ponomareva IV, Maltsev VG, Yakushev KB, Sherman MA. Clinical variants of limbic encephalitis. *SAGE Open Med Case Rep*. 2019;7:2050313X19846042. Published 2019 May 2. doi:10.1177/2050313X19846042
7. Oyanguren B, Sánchez V, González FJ, et al. Limbic encephalitis: a clinical-radiological comparison between herpetic and autoimmune etiologies. *Eur J Neurol*. 2013;20(12):1566-1570. doi:10.1111/ene.12249
8. Lancaster E, Dalmau J. Neuronal autoantigens--pathogenesis, associated disorders and antibody testing. Nat Rev Neurol. 2012;8(7):380-390. Published 2012 Jun 19. doi:10.1038/nrneurol.2012.99
9. Budhram A, Leung A, Nicolle MW, Burneo JG. Diagnosing autoimmune limbic encephalitis. *CMAJ*. 2019;191(19):E529-E534. doi:10.1503/cmaj.181548
10. Munshi SK, Thanvi B, Chin SK, Hubbard I, Fletcher A, Vallance TR. Paraneoplastic limbic encephalitis--case report and review of literature. *Age Ageing*. 2005;34(2):190-193. doi:10.1093/ageing/afi017
11. Dalmau J, Gleichman AJ, Hughes EG, et al. Anti-NMDA-receptor encephalitis: case series and analysis of the effects of antibodies. *Lancet Neurol*. 2008;7(12):1091-1098. doi:10.1016/S1474-4422(08)70224-2
12. Titulaer MJ, McCracken L, Gabilondo I, et al. Treatment and prognostic factors for long-term outcome in patients with anti-NMDA receptor encephalitis: an observational cohort study. *Lancet Neurol*. 2013;12(2):157-165. doi:10.1016/S1474-4422(12)70310-1
13. Spatola M, Sabater L, Planagumà J, et al. Encephalitis with mGluR5 antibodies: Symptoms and antibody effects. *Neurology*. 2018;90(22):e1964-e1972. doi:10.1212/WNL.0000000000005614
14. Laurido-Soto O, Brier MR, Simon LE, McCullough A, Bucelli RC, Day GS. Patient characteristics and outcome associations in AMPA receptor

encephalitis. *J Neurol*. 2019;266(2):450-460. doi:10.1007/s00415-018-9153-8

15. Irani SR, Alexander S, Waters P, et al. Antibodies to Kv1 potassium channel-complex proteins leucine-rich, glioma inactivated 1 protein and contactin-associated protein-2 in limbic encephalitis, Morvan's syndrome and acquired neuromyotonia. *Brain*. 2010;133(9):2734-2748. doi:10.1093/brain/awq213
16. Irani SR, Michell AW, Lang B, et al. Faciobrachial dystonic seizures precede Lgi1 antibody limbic encephalitis. *Ann Neurol*. 2011;69(5):892-900. doi:10.1002/ana.22307
17. van Sonderen A, Ariño H, Petit-Pedrol M, et al. The clinical spectrum of Caspr2 antibody-associated disease. *Neurology*. 2016;87(5):521-528. doi:10.1212/WNL.0000000000002917
18. van Coevorden-Hameete MH, de Bruijn MAAM, de Graaff E, et al. The expanded clinical spectrum of anti-GABABR encephalitis and added value of KCTD16 autoantibodies. *Brain*. 2019;142(6):1631-1643. doi:10.1093/brain/awz094
19. Mansoor, S., Murphy, K. Anti-GAD-associated limbic encephalitis: an unusual clinical manifestation from northwest of Ireland. *Egypt J Neurol Psychiatry Neurosurg* **56**, 23 (2020). https://doi.org/10.1186/s41983-020-0160-1
20. Dalmau J, Graus F, Rosenblum MK, Posner JB. Anti-Hu--associated paraneoplastic encephalomyelitis/sensory neuronopathy. A clinical study of 71 patients. *Medicine (Baltimore)*. 1992;71(2):59-72. doi:10.1097/00005792-199203000-00001
21. Gultekin SH, Rosenfeld MR, Voltz R, Eichen J, Posner JB, Dalmau J. Paraneoplastic limbic encephalitis: neurological symptoms, immunological findings and tumour association in 50 patients. *Brain*. 2000;123 (Pt 7):1481-1494. doi:10.1093/brain/123.7.1481
22. Dalmau J, Graus F, Villarejo A, et al. Clinical analysis of anti-Ma2-associated encephalitis. *Brain*. 2004;127(Pt 8):1831-1844. doi:10.1093/brain/awh203
23. Castle J, Sakonju A, Dalmau J, Newman-Toker DE. Anti-Ma2-associated encephalitis with normal FDG-PET: a case of pseudo-Whipple's

disease. *Nat Clin Pract Neurol.* 2006;2(10):566-573. doi:10.1038/ncpneuro0287

24. Yu Z, Kryzer TJ, Griesmann GE, Kim K, Benarroch EE, Lennon VA. CRMP-5 neuronal autoantibody: marker of lung cancer and thymoma-related autoimmunity. *Ann Neurol.* 2001;49(2):146-154.
25. Baumgartner, A., Rauer, S., Hottenrott, T. *et al.* Admission diagnoses of patients later diagnosed with autoimmune encephalitis. *J Neurol* **266**, 124–132 (2019). https://doi.org/10.1007/s00415-018-9105-3
26. Granerod J, Ambrose HE, Davies NW, et al.: Causes of encephalitis and differences in their clinical presentations in England: a multicentre, population-based prospective study. Lancet Infect Dis. 2010, 10:835-44. 10.1016/s1473-3099(10)70222-x
27. van Sonderen A, Thijs RD, Coenders EC, et al. Anti-LGI1 encephalitis: clinical syndrome and long-term follow-up. *Neurology* 2016;87:1449-56.
28. Chow FC, Glaser CA, Sheriff H, et al. Use of clinical and neuroimaging characteristics to distinguish temporal lobe herpes simplex encephalitis from its mimics. *Clin Infect Dis* 2015;60:1377-83.
29. Vogrig A, Joubert B, Ducray F, et al. Glioblastoma as differential diagnosis of autoimmune encephalitis. *J Neurol* 2018;265:669-77.
30. Hosoki S, Satoi H, Matsumoto S. Bilateral hippocampal infarction mimicking limbic encephalitis. *Intern Med* 2018;57:911-2.
31. Kim JA, Chung JI, Yoon PH, et al. Transient MR signal changes in patients with generalized tonicoclonic seizure or status epilepticus: periictal diffusionweighted imaging. *AJNR Am J Neuroradiol* 2001;22:1149-60.
32. Newey CR, Sarwal A, Hantus S. [(18)F]-fluoro-deoxy-glucose positron emission tomography scan should be obtained early in cases of autoimmune encephalitis. *Autoimmune Dis* 2016;2016:9450452.
33. Pessa ME, Janes F, Gigli GL. Electroencephalographic evaluation for early diagnosis of limbic encephalitis. *Clin EEG Neurosci* 2016;47:207-10.
34. Vincent A, Buckley C, Schott JM, et al. Potassium channel antibody-associated encephalopathy: a potentially immunotherapy-responsive form of limbic encephalitis. *Brain* 2004;127:701-12.

35. Malter MP, Elger CE, Surges R. Diagnostic value of CSF findings in antibody-associated limbic and anti-NMDAR-encephalitis. *Seizure*. 2013;22(2):136-140. doi:10.1016/j.seizure.2012.12.013
36. Weil AA, Glaser CA, Amad Z, Forghani B. Patients with suspected herpes simplex encephalitis: rethinking an initial negative polymerase chain reaction result. *Clin Infect Dis*. 2002;34(8):1154-1157. doi:10.1086/339550
37. Gadoth A, Pittock SJ, Dubey D, et al. Expanded phenotypes and outcomes among 256 LGI1/CASPR2-IgG-positive patients. *Ann Neurol*. 2017;82(1):79-92. doi:10.1002/ana.24979
38. Lancaster E, Lai M, Peng X, et al. Antibodies to the GABA(B) receptor in limbic encephalitis with seizures: case series and characterisation of the antigen. *Lancet Neurol*. 2010;9(1):67-76. doi:10.1016/S1474-4422(09)70324-2
39. Mueller C, Elben S, Day GS, et al. Review and meta-analysis of neuropsychological findings in autoimmune limbic encephalitis with autoantibodies against LGI1, CASPR2, and GAD65 and their response to immunotherapy. *Clin Neurol Neurosurg*. 2023;224:107559. doi:10.1016/j.clineuro.2022.107559
40. Viaccoz A, Desestret V, Ducray F, et al. Clinical specificities of adult male patients with NMDA receptor antibodies encephalitis. *Neurology*. 2014;82(7):556-563. doi:10.1212/WNL.0000000000000126