EUROPEAN PAEDIATRIC NEUROLOGY SOCIETY

Neuroborreliosis and other transmitted diseases with neurological impact

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Universität Witten/Herdecke,
Germany

universität Witten/Herdecke

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Overview

- Introduction (Role of CSF studies in general and in NB)
- Neuroborreliosis (NB) with cases
- FSME/TBE
- Dengue-Virus-Enzephalitis
- Quiz with 3 cases
- Summary

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A standardized approach in CSF testing is strongly recommended:

- Cell count with differential, glucose, lactate, cytology
- Total protein and Albumin-quotient
- Quantitative Immunglobuline measurement
- Oligoclonal IgG and specific antibodies,
- Biomarkers such as NFL, GFAP, hypocretin as indicated
- Opening pressure!!!

- *CSF/Blood Culture*
- *Multiplex PCR (viral and bacterial pathogens in CSF)*
- *Throat swab, stool sample*
- *Serological studies in blood as indicated*

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Standardized CSF diagnostics allows for detailed interpretation:

- Morphology of detected cells
- Blood-CSF barrier dysfunction
- Intrathecal IG- synthesis (IgG, IgA, IgM)
- specific antibody synthesis

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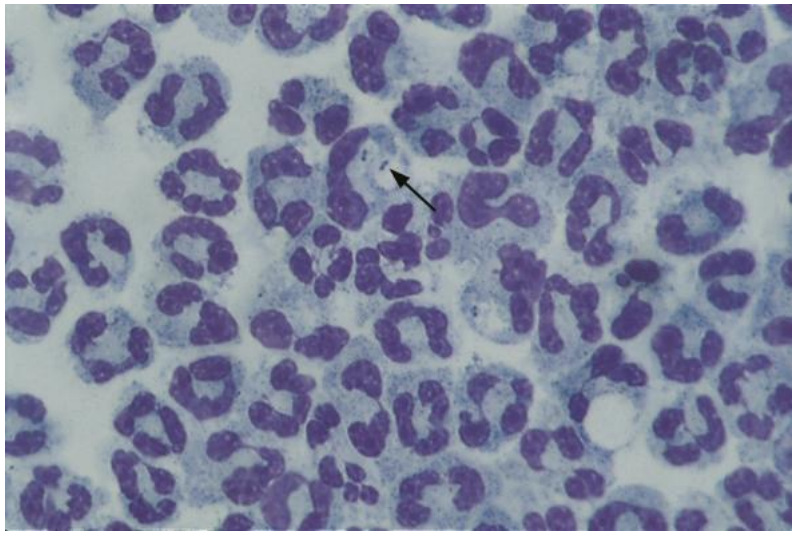
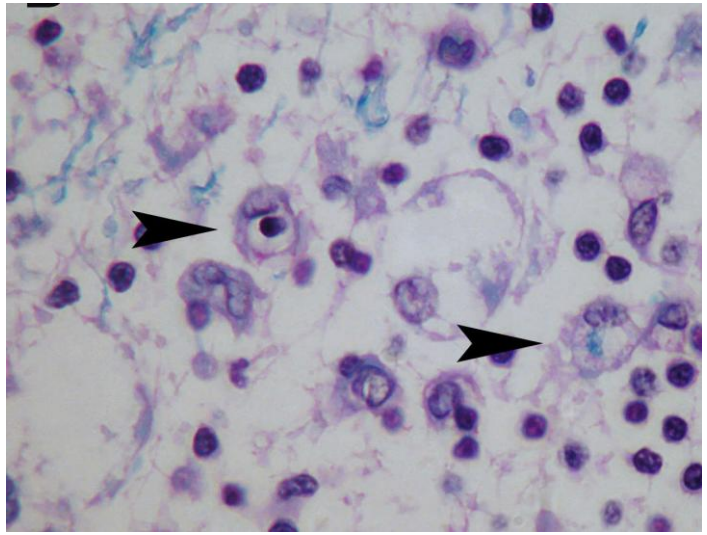
Morphology of detected cells!!!!

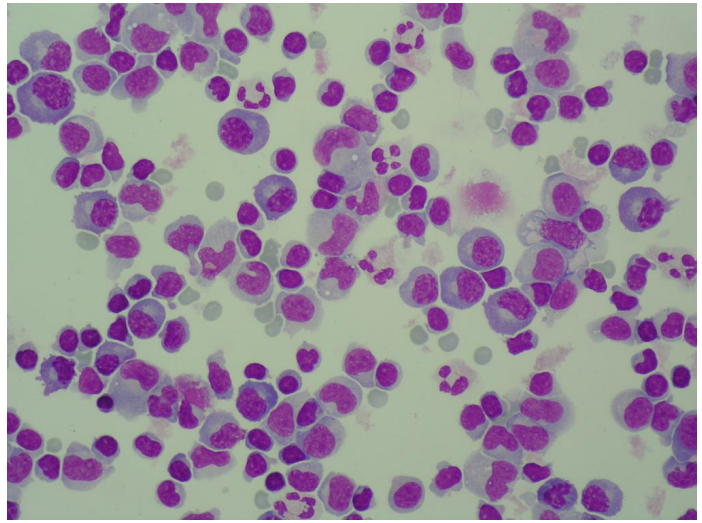


Pneumoccoccal meningitis



Emperipolesis-HLH

Neuroborreliose



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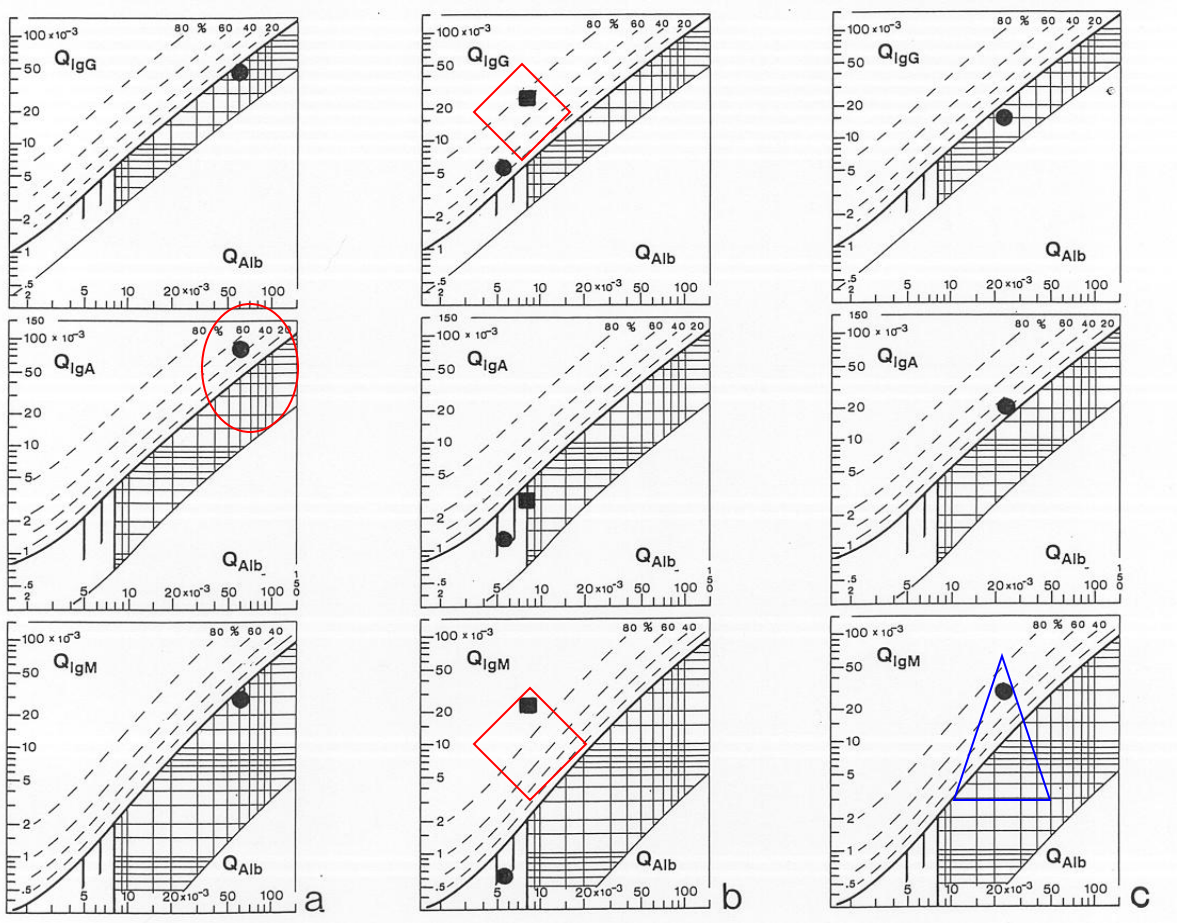

1-,2-oder 3-Immunglobulin-class-reaction

„**Dominance**“

Neurotuberkulose
(IgA)

Neurosyphilis
(IgG,IgM)
MS (IgG>IgM

Neuroborreliose
(IgM>IgG>IgA)
Opportunistische Infektionen
(CMV, Toxoplasmose)

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Neurology OPEN ACCESS Guideline

Guidelines for diagnosis and treatment in neurology – Lyme neuroborreliosis

Leitlinien für Diagnostik und Therapie in der Neurologie – Neuroborreliose

Abstract

Lyme borreliosis is the most common tick-borne infectious disease in Europe. A neurological manifestation occurs in 3–15% of infections and can manifest as polyradiculitis, meningitis and (rarely) encephalomyelitis. This S3 guideline is directed at physicians in private practices and clinics who treat Lyme neuroborreliosis in children and adults.

Twenty AWMF member societies, the Robert Koch Institute, the German Borreliosis Society and three patient organisations participated in its development. A systematic review and assessment of the literature was conducted by the German Cochrane Centre, Freiburg (Cochrane Germany).

The main objectives of this guideline are to define the disease and to give recommendations for the confirmation of a clinically suspected diagnosis by laboratory testing, antibiotic therapy, differential diagnostic testing and prevention.

Sebastian Rauer[1]
Stephan Kastenbauer[1]
Heidelore Hofmann[2]
Volker Fingerle[3]
Hans-Iko Huppertz[4,5]
Klaus-Peter Hunfeld[6,7]
Andreas Krause[8]
Bernhard Ruf[9]
Rick Dersch[1,10]
Consensus group

Rauer et al.: Guidelines for diagnosis and treatment in neurology , 2020

Neurology OPEN ACCESS Guideline

Guidelines for diagnosis and treatment in neurology – Lyme neuroborreliosis

Leitlinien für Diagnostik und Therapie in der Neurologie – Neuroborreliose

Abstract

Lyme borreliosis is the most common tick-borne infectious disease in Europe. A neurological manifestation occurs in 3–15% of infections and can manifest as polyradiculitis, meningitis and (rarely) encephalomyelitis. This S3 guideline is directed at physicians in private practices and clinics who treat Lyme neuroborreliosis in children and adults.
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Possible neuroborreliosis

- Typical clinical picture (cranial nerve deficits, meningitis/meningoradiculitis, focal neurological deficits; cf. Section 2.4)
- Borrelia-specific IgG and/or IgM antibodies in serum (*The serology may [still] be negative in very early stages of the disease*)
- CSF findings not available/spinal tap not performed
- Differentiation from other causes

[illegible]

with “possible Lyme neuroborreliosis”, however additionally

Inflammatory cerebrospinal fluid syndrome with lymphocytic pleocytosis, blood-CSF barrier dysfunction and intrathecal immunoglobulin synthesis

with “probable Lyme neuroborreliosis”, however additionally

Intrathecal synthesis of Borrelia-specific antibodies (positive IgG and/or IgM antibody index) in CSF or
Positive culture or nucleic acid detection (PCR) in

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Liquor-Programm

Neurochemisches Labor der Neurologischen Klinik
Universitätsmedizin Göttingen
Robert-Koch-Straße 40, 37075 Göttingen, Tel. 0551/396620
Prof. Dr. med. I. Zerr, PD Dr. med. A. Spreer
Prof. Dr. med. M. Bähr
Ausbildungslabor der DGLN

Einsender
Tel :
Station: Kurs

Pkt.-Datum: 27.09.2000

Patient

Patient 15

Geburtsdatum : 18.12.1970 Geschlecht : u
Alter: 29,8

Pkt.-datum : 27.09.2000 Eingangsdatum 27.09.2000
Pkt.-Uhrzeit : Eingangszeit: 11:26
Arzt :

Differentialdiagnostische Fragestellung
keine Angabe.

Punktion	Beschaffenheit	Hb
LP	klar	0

Zellen

Zellzahl 880 /µl Ery 45 /µl
Lymphoz. 71 % Monoz 11 % n.Granuloz 9 % Plasma-Z. 9 %
sonstige Zellen :

Lactat 1,8 mmol/L

Proteine

	CSF		Serum		Q(CSF/Ser)*10³		lokale Synthese (IF)
GEW	2193	mg/L					
Albumin	1400	mg/L	46,3	g/L	Q_{Alb} =	30,2	
IgG	332	mg/L	9,8	g/L	Q_{IgG} =	33,9	22 %
IgA	31,8	mg/L	2,0	g/L	Q_{IgA} =	15,9	%
IgM	54,3	mg/L	1,2	g/L	Q_{IgM} =	45,2	68 %

Oligoklonales IgG

Oligoklonales IgG CSF =
Oligoklonales IgG Ser =

Spez. Antikörper (Synthese im ZNS: AI ≥1,5)

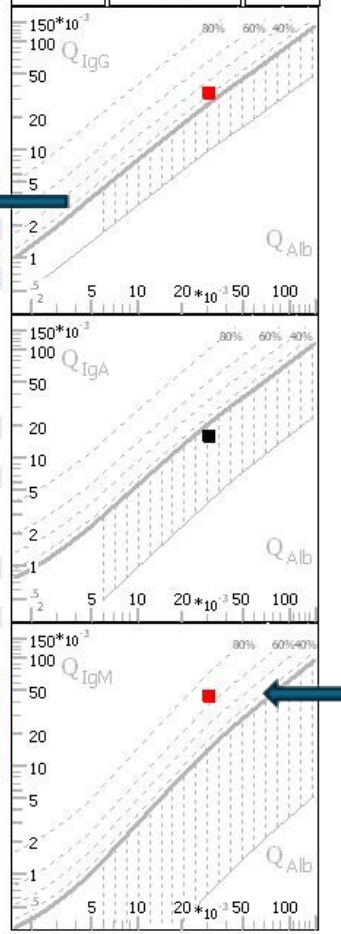
Masern-AI	=	EBV-AI	=	TP-AI(IgG)	=
Röteln-AI	=	CMV-AI	=	TP-AI(IgM)	=
VZV-AI	=	Borr-AI(IgG)	= 13,7	FSME-AI(IgG)	=
HSV-AI	=	Borr-AI(IgM)	= 8,1	FSME-AI(IgM)	=

Prozessmarker (Tumor, Demenz, neurodegenerative Erkrankungen etc.)

Beurteilung

Normaler Liquorbefund ○	Normaler Liquorproteinbefund ○
Schrankenfunktionsstörung ○	Zellzahl erhöht ○
Lactat erhöht ○	Spez. AK-Synthese im ZNS ○
Entzündlicher Prozess im ZNS ○	Patholog. Demenz-/Destruktionsmarker ○

Kommentare



Constellation of CSF findings indicates acute neuroborreliosis

Endbericht erstellt am: 30.11.2012 09:12

Liquor-Programm

Neurochemisches Labor der Neurologischen Klinik
Universitätsmedizin Göttingen
Robert-Koch-Straße 40, 37075 Göttingen, Tel. 0551/396620
Prof. Dr. med. I. Zerr, PD Dr. med. A. Spreer
Prof. Dr. med. M. Bähr
Ausbildungslabor der DGLN

Einsender

Tel :

Station: Kurs

Pkt.-Datum: 09.10.2000

Patient

Patient 15a

Geburtsdatum : 18.12.1970 Geschlecht : u
Alter: 29,9

Pkt.-datum : 09.10.2000 Eingangsdatum 09.10.2000
Pkt.-Uhrzeit : Eingangszeit: 11:31
Arzt :

Differentialdiagnostische Fragestellung
Kontrolle nach Neuroborreliose, nach ca. 2 Wochen

Punktion	Beschaffenheit	Hb
LP	klar	0

Zellen

Zellzahl 311 /µl Ery 18 /µl

Lymphoz. 94 % Monoz 4 % n.Granuloz % Plasma-Z. 2 %

sonstige Zellen :

Lactat 1,5 mmol/L

Proteine

	CSF		Serum		Q(CSF/Ser)*10³		lokale Synthese (IF)
GEW	1460	mg/L					
Albumin	739	mg/L	44,4	g/L	Q_{Alb} =	16,6	
IgG	164	mg/L	10,2	g/L	Q_{IgG} =	16,1	14 %
IgA	16,5	mg/L	2,1	g/L	Q_{IgA} =	7,9	%
IgM	20,7	mg/L	1,2	g/L	Q_{IgM} =	17,2	64 %

Oligoklonales IgG

Oligoklonales IgG CSF = +

Oligoklonales IgG Ser = Ø

Spez. Antikörper (Synthese im ZNS: AI ≥1,5)

Masern-AI	=	EBV-AI	=	TP-AI(IgG)	=
Röteln-AI	=	CMV-AI	=	TP-AI(IgM)	=
VZV-AI	=	Borr-AI(IgG)	= 9,3	FS	
HSV-AI	=	Borr-AI(IgM)	= 3,2	FSME-AI(IgM)	=

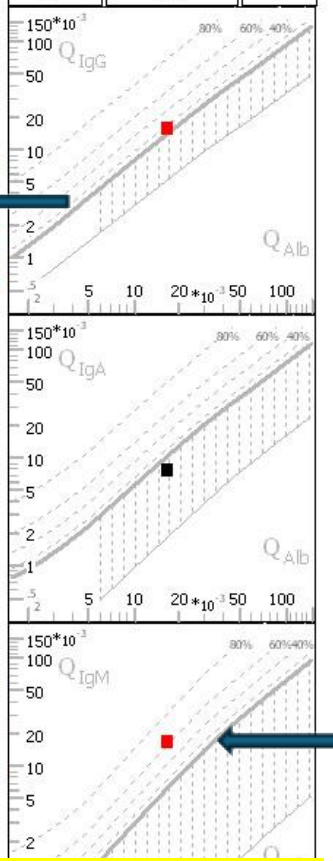
Prozessmarker (Tumor, Demenz, neurodegenerative Erkrankungen etc.)

Beurteilung

Normaler Liquorbefund	○	Normaler Liquorproteinbefund	○
Schrankenfunktionsstörung	✗	Zellzahl erhöht	✗
Lactat erhöht	○	Spez. AK-Synthese im ZNS	✗
Entzündlicher Prozess im ZNS	✗	Patholog. Demenz-/Destruktionsmarker	○

Kommentare

Oligoklonales IgG im Liquor!



Cell count and Blood-CSF barrier dysfunction improving as a sign for succesful AB treatment!

Endbericht erstellt am:

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Elevated Borrelien AI-values (also IgM !) as an old „scare“ many years later often seen.
Cell count and Blood-CSF barrier function normal!!!
No sign of relapse!!!!!

Liquor-Programm

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Prof. Dr. med. I. Zerr, PD Dr. med. A. Spreer
Prof. Dr. med. M. Bähr
Ausbildungslabor der DGLN

Einsender
Tel :
Station: Kurs

Pkt.-Datum: 02.07.2004

Patient

Patient 15b

Geburtsdatum : 18.12.1970 Geschlecht : u
Alter: 33,6

Pkt.-datum :	02.07.2004	Eingangsdatum	07.07.2004
Pkt.-Uhrzeit :		Eingangszeit:	11:34
Arzt :			

Differentialdiagnostische Fragestellung
Z.n. Neuroborreliose 1999, nach ca. 4 Jahren

Punktion	Beschaffenheit	Hb
LP	klar	0

Zellen

Zellzahl /µl Ery /µl

Lymphoz. % Monoz % n.Granuloz % Plasma-Z. %

sonstige Zellen :

Lactat mmol/L

Proteine

	CSF		Serum		Q(CSF/Ser)*10³		lokale Synthese (IF)
GEW	408	mg/L					
Albumin	226	mg/L	46,8	g/L	Q_{Alb} =	4,8	
IgG	24,5	mg/L	9,4	g/L	Q_{IgG} =	2,6	%
IgA	2,1	mg/L	2,1	g/L	Q_{IgA} =	1,0	%
IgM	0,30	mg/L	1,2	g/L	Q_{IgM} =	0,25	%

Oligoklonales IgG

Oligoklonales IgG CSF = | Oligoklonales IgG Ser =

Spez. Antikörper (Synthese im ZNS: AI ≥1,5)

Masern-AI	=	EBV-AI	=	TP-AI(IgG)	=
Röteln-AI	=	CMV-AI	=	TP-AI(IgM)	=
VZV-AI	=	Borr-AI(IgG)	= 48,3	FSME-AI(IgG)	=
HSV-AI	=	Borr-AI(IgM)	= 25,3	FSME-AI(IgM)	=

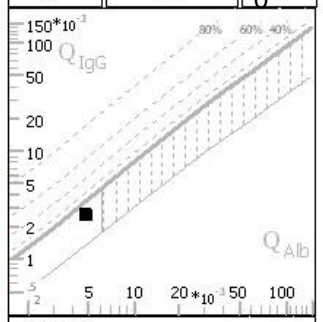
Prozessmarker (Tumor, Demenz, neurodegenerative Erkrankungen etc.)

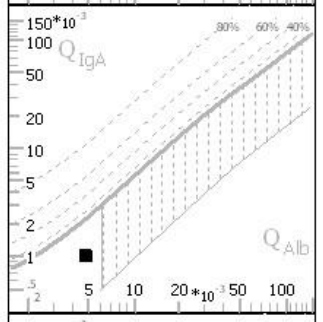
Beurteilung

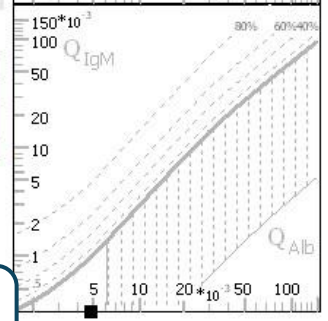
Normaler Liquorbefund	○	Normaler Liquorproteinbefund	○
Schrankenfunktionsstörung	○	Zellzahl erhöht	○
Lactat erhöht	○	Spez. AK-Synthese im ZNS	✕
Entzündlicher Prozess im ZNS	✕	Patholog. Demenz-/Destruktionsmarker	○

Kommentare

Sehr niedrige Borr.(IgG + IgM)- AKTiter im Serum.
Zellzahl wurde beim Einsender bestimmt: Leuco: 4/µl.







Endbericht erstellt am:

Very low serum Borr.(IgG + IgM – Ab titer

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Case 1 History and symptoms

- 14-yo boy presented with gait unsteadiness after getting up one morning
- Anisocoria with a small pupil and a mild ptosis on the right (Horner´s syndrome), a right sided ataxia and falling tendency to the right, deviation of the soft palate to the left, a change of his voice and a hypoaesthesia (temperature) of the left side of the body and the left side of the face.
- Neurological symptoms suitable for a lateral medullary syndrome (also called Wallenberg syndrome or posterior inferior cerebellar artery syndrome).

Kindly provided by M.Baumann, Innsbruck

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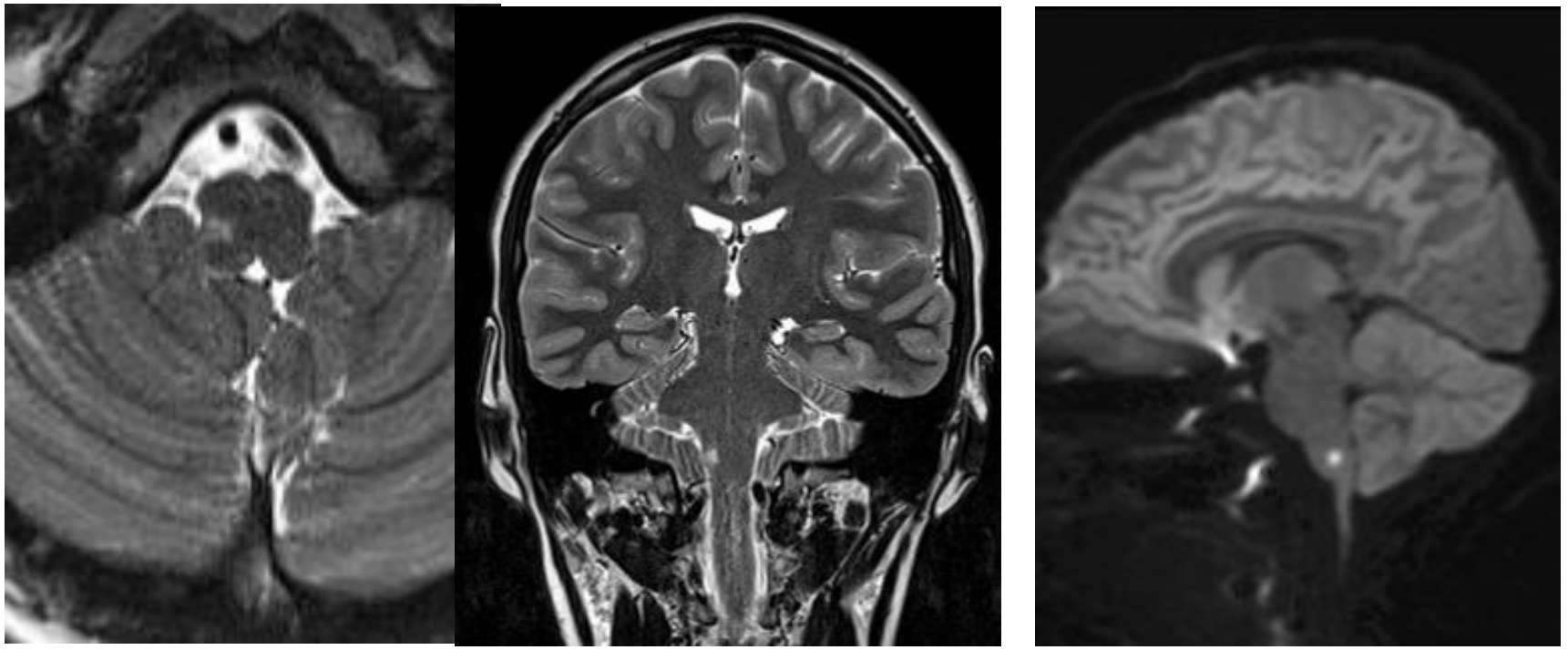
Acute brain stem infarction- Wallenberg Syndrom



- The MRI showed a right sided dorsal lateral medullary infarction

Laboratory results and Treatment

- Serum antibodies positive for IgM and IgG against Borrrelia burgdorferie
- CSF: high protein content, lymphocytic pleocytosis (116 cells/µl), IgG synthesis, OCB negative.
- Borrelia burgdorferi CSF/serum IgG antibody index (AI) was markedly elevated (38.7).
- T_x with iv. ceftriaxone for 14 days +200 mg acetylsalicylic acid.

- CAVE: NB can rarely present as a meningovascular inflammation leading to infarction. Especially in children ischemic stroke is a rare manifestation and a localization in the brain stem like in our patient has been reported only in isolated cases.

Case 2: 13 yo girl with acute onset of central 7th nerve palsy

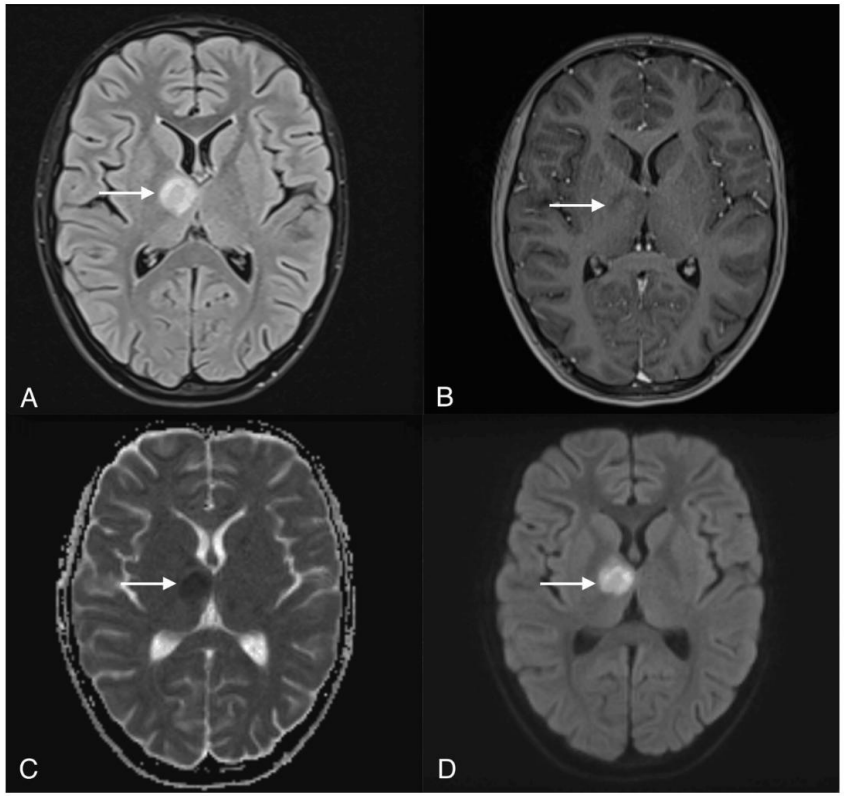


FIGURE 1: Day 5 from the onset of facial nerve palsy symptoms. Brain MRI at admission to the Pediatric Department demonstrates a pathological oval lesion in the right thalamus and internal capsule, hyperintense on T2 FLAIR (A) with trace enhancement on post-contrast T1-weighted imaging (B). Restricted diffusion is seen on the ADC map (C) and DWI (D). Arrows indicate the lesion.

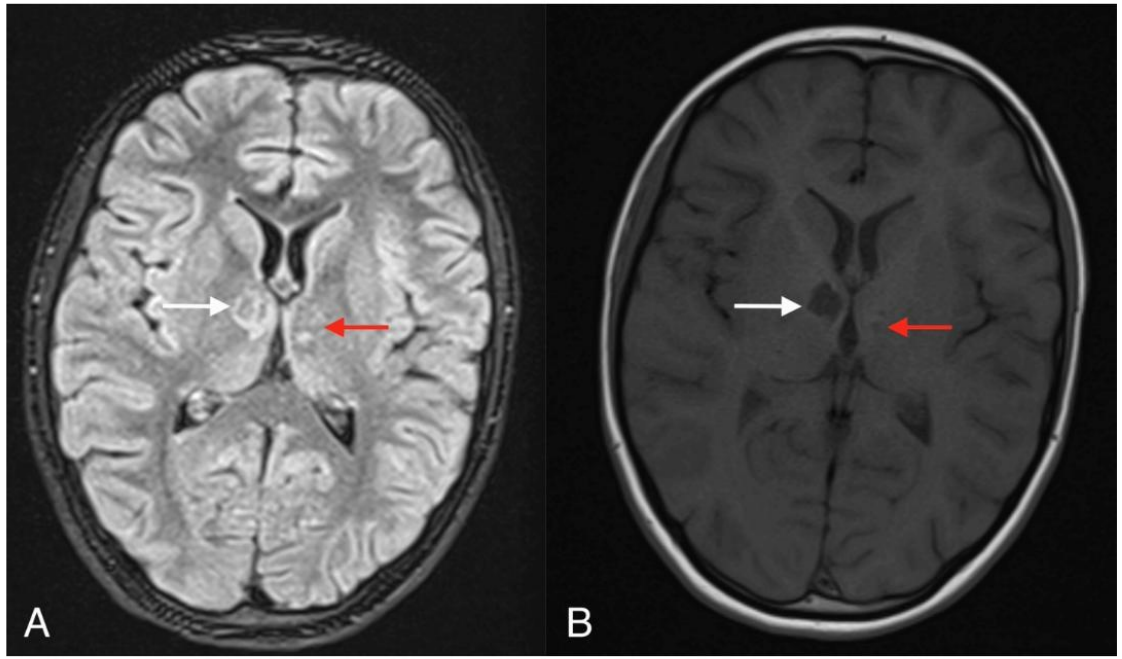


FIGURE 3: Week 18 from symptom onset. Follow-up brain MRI performed in the Infectious Diseases Department shows an area of malacia in the basal ganglia and thalamus (white arrow) and small foci of porencephaly in the left basal ganglia (red arrow) on T2 FLAIR (A) and post-contrast T1-weighted imaging (B).

Sendor et al, 2025

Review > Pediatr Neurol. 2024 Mar:152:196-199. doi: 10.1016/j.pediatrneurol.2023.12.025.
Epub 2024 Jan 2.

Isolated Intracranial Hypertension as a Presentation of Pediatric Lyme Borreliosis: A Case Report and Literature Review

Jeffrey M Mah [1], Cody Lo [2], Michael D O'Connor [2]

Affiliations + expand

PMID: 38301323 DOI: 10.1016/j.pediatrneurol.2023.12.025

Results: A 13-year-old male presented with five days of binocular diplopia, several weeks of headache, and a history of multiple tick bites six weeks prior. His examination showed a left eye abduction deficit and bilateral optic disc edema. Magnetic resonance imaging (MRI) of the brain with contrast showed tortuosity of the optic nerves, prominence of the optic nerve sheaths, and enhancement of the left fifth and bilateral sixth cranial nerves. Lumbar puncture showed an elevated opening pressure and a lymphocytic pleocytosis. Lyme IgM and IgG antibodies were positive in the serum and cerebrospinal fluid. The patient was treated with intravenous ceftriaxone for two days empirically followed by doxycycline by mouth for 19 days. Symptoms began improving after 48 hours. The strabismus resolved after two weeks, and the papilledema improved slowly with complete resolution at six months.

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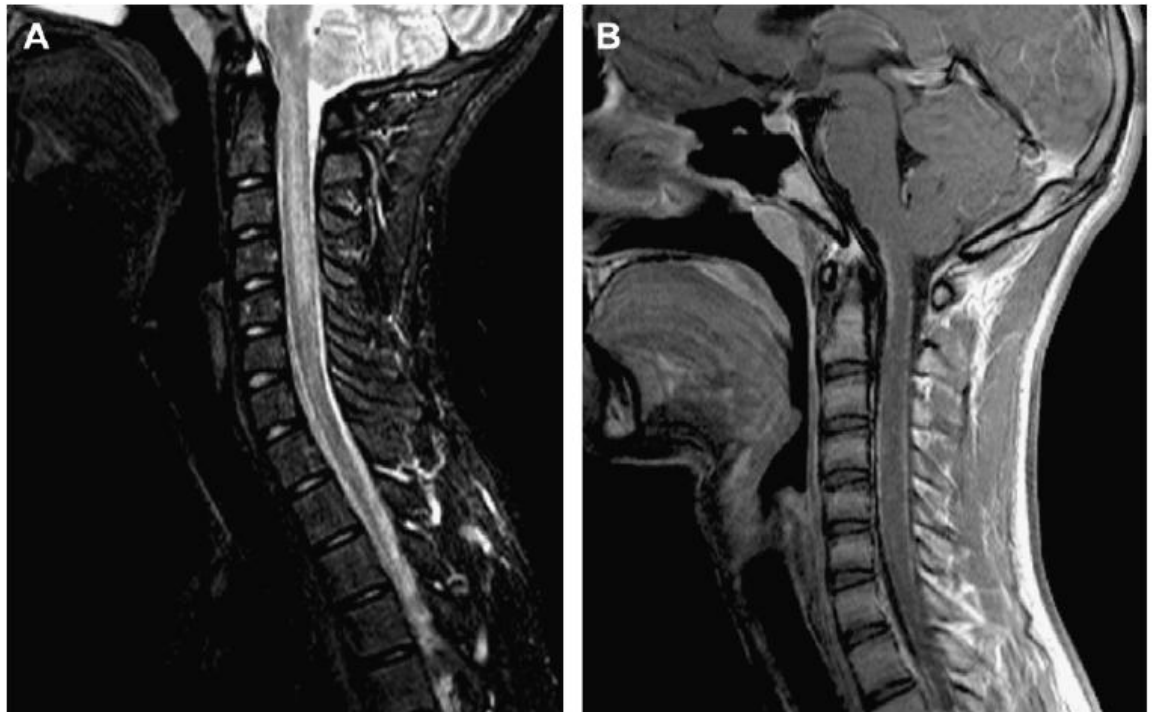
Case 3:

- 16 yo boy: bilateral weakness in arms/legs,
- Spinal MRI: LETM, meningeale enhancement!
- CSF: Protein 109mg/dl, 442 cells/µl.



Bauman et al, 2008

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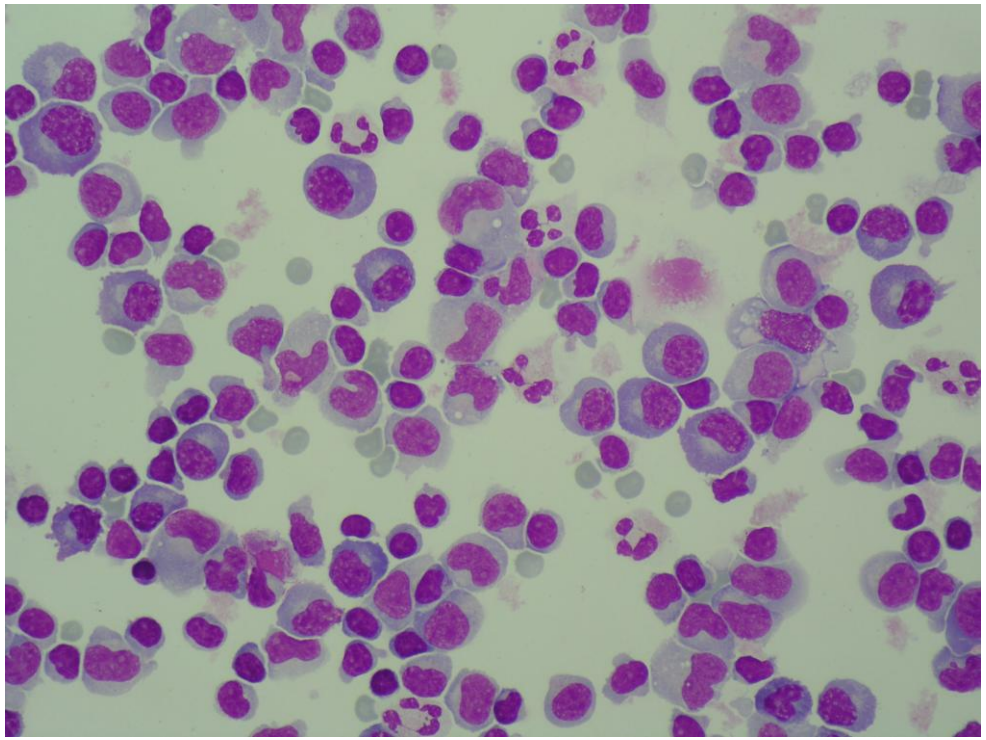
Case 3: Neuroborreliose with LETM

- CSF: Protein 109mg/dl, 442 cells/µl.
- IgM und IgG antibodies against Borrelien present
- Borrelia burgdorferi-IgG- AI elevated!



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Treatment of NB in children

ORIGINAL ARTICLE OPEN ACCESS

Oral Doxycycline Was a Safe and Feasible Treatment in Young Children With Neuroborreliosis

Joakim Bloch[1,2] | Lisbeth Schmidt[2,3] | Nadja Vissing[1] | Jonathan Peter Glenthøj[4] | Birgitte Smith[2,5] | Alfred Peter Born[1] | Anja Poulsen[1] | Anne-Mette Lebech[2,6] | Ulrikka Nygaard[1,2]

[1]Department of Paediatrics and Adolescent Medicine, Copenhagen University Hospital – Rigshospitalet, Copenhagen, Denmark | [2]Department of Clinical Medicine, Faculty of Health and Medical Sciences, Copenhagen University, Copenhagen, Denmark | [3]Department of Children and Adolescents, Copenhagen University Hospital – Herlev and Gentofte, Herlev, Denmark | [4]Department of Children and Adolescents, Copenhagen University Hospital – North Zealand Hospital, Hilleroed, Denmark | [5]Department of Children and Adolescents, Copenhagen University Hospital – Amager and Hvidovre, Hvidovre, Denmark | [6]Department of Infectious Diseases, Copenhagen University Hospital – Rigshospitalet, Copenhagen, Denmark

Correspondence: Joakim Bloch (joakim.bloch@regionh.dk)

Received: 14 January 2025 | **Revised:** 28 March 2025 | **Accepted:** 31 March 2025

Funding: The project was funded by the Research Fund of Copenhagen University Hospital, Rigshospitalet.

Keywords: antibiotic stewardship | *Borrelia burgdorferi* | doxycycline | neuroborreliosis | tick-borne pathogens

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> J Child Psychol Psychiatry. 2025 May;66(5):716-724. doi: 10.1111/jcpp.14079. Epub 2024 Dec 1.

No associations between neuroborreliosis in children and psychiatric neurodevelopmental disorders: a nationwide, population-based, matched cohort study

Malte M Tetens [1], Emma E Graham [1], Nanna S Andersen [2 3], Jette Bangsborg [4], Jacob Bodilsen [5 6], Ram B Dessau [7 8], Svend Ellermann-Eriksen [9], Charlotte Sværke Jørgensen [10], Jens Kjølseth Møller [8 11], Alex Christian Yde Nielsen [12], Michael Pedersen [13], Kirstine K Søgaard [6 14], Dorrit Obel [15], Ulrikka Nygaard [16 17], Niels Obel [1 17], Anne-Mette Lebech [1 17], Lars Haukali Omland [1]

Affiliations + expand

PMID: 39618006 DOI: 10.1111/jcpp.14079

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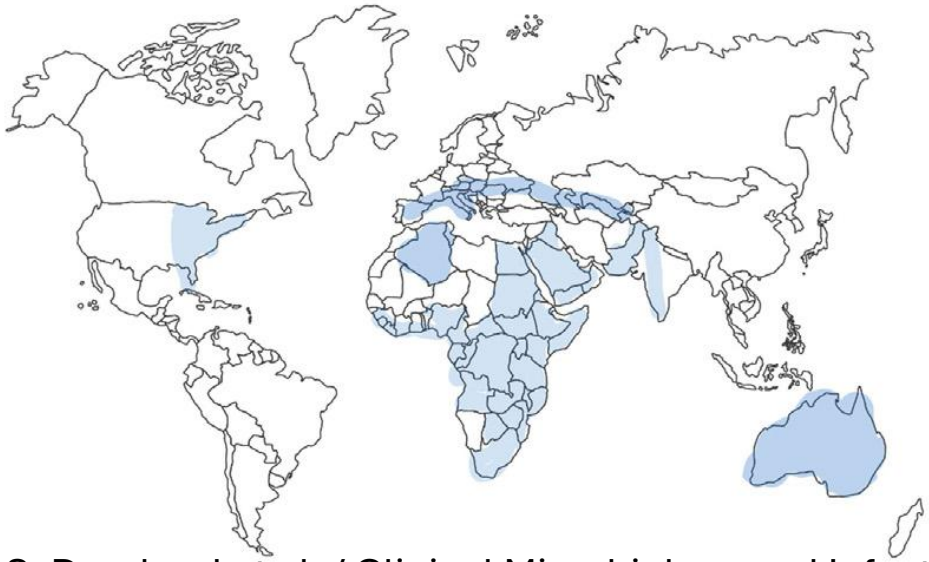
Geographic distribution of selected endemic aetiological agents of infectious encephalitis

Japanese Encephalitis virus

Tick Borne encephalitis Virus (European subtype)

West Nile virus



Dengue virus

L.S. Duerlund et al. / Clinical Microbiology and Infection 31 (2025) 515e521

Adapted from WHO: https://www.who.int/emergencies/disease-outbreak-news .

Flavivirus encephalitis (Sami et al. 2025)

Parameter	Dengue Encephalitis (DE)	Japanese Encephalitis (JE)	Zika Virus Encephalitis (ZVE)	West Nile Virus Encephalitis (WNVE)
Causative Virus	Dengue virus (DENV-1 to DENV-4) – Flavivirus	Japanese encephalitis virus (JEV) – Flavivirus	Zika virus (ZIKV) – Flavivirus	West Nile virus (WNV) – Flavivirus
Primary Transmission	Aedes aegypti mosquito	Culex mosquitoes (primarily C. tritaeniorhynchus)	Aedes mosquitoes (A. aegypti, A. albopictus)	Culex mosquitoes
Epidemiology	Endemic in >100 countries in Asia, Africa, and Latin America	Endemic in Southeast Asia, Western Pacific	Endemic to Southeast Asia and Southern Asia	Endemic in Africa, Middle East, and Americas; outbreaks in Europe/USA
Age Group Most Affected	All ages; severe CNS involvement is more common in children and young adults	Children <15 years in endemic areas	Adults; CNS disease is rare, more in neonates and immunocompromised	Elderly and immunocompromised; increased neuroinvasive disease risk
Neurological Symptoms	Seizures, altered sensorium, focal deficits, brainstem signs, raised ICP	Fever, headache, seizures, altered consciousness, parkinsonian features, flaccid palsy	Confusion, meningoencephalitis, seizures, congenital CNS malformations in neonates	Encephalitis, acute flaccid paralysis, tremors, movement disorders
Blood-brain barrier (BBB) Involvement	Disruption reported; virus found in CSF and brain parenchyma	Evident in pathology and animal models	Impaired BBB integrity in models	BBB disruption and neuronal injury confirmed
CSF Findings	Mild lymphocytic pleocytosis, elevated protein, normal glucose; DENV RNA/IgM	Lymphocytic pleocytosis, elevated protein, JEV IgM, or PCR positive	Mild pleocytosis, elevated protein; ZIKV RNA/IgM in CSF	Pleocytosis, elevated protein, WNV IgM, or PCR positive
Neuroimaging Findings (MRI/CT)	Bilateral thalamic/basal ganglia lesions ± hemorrhage; brainstem edema	Bilateral thalamic and midbrain T2 hyperintensities; substantia nigra involvement	Hyperintense white matter lesions, brainstem/cerebellar involvement	T2 hyperintensities in deep gray nuclei, brainstem, spinal cord
Diagnosis	DENV NS1 antigen, IgM/IgG, RT-PCR; MRI findings support	JEV IgM ELISA, PCR, MRI	RT-PCR from serum/CSF/urine, IgM ELISA, imaging	WNV IgM (serum/CSF), PCR, compatible imaging and symptoms
Mortality Rate	~22–33 % of encephalitis cases	20–30 % in symptomatic neuroinvasive disease	<5% in neuroinvasive disease; higher in neonates	~10 % in hospitalized cases; higher in elderly
Long-Term Neurological Sequelae	Seizures, memory loss, motor deficits, cognitive impairment	Intellectual disability, movement/speech disorders	Developmental delay, microcephaly (in congenital cases)	Fatigue, tremors, cognitive/motor deficits
tment	Supportive (hydration, antipyretics, anticonvulsants); no antivirals	Supportive; no approved antivirals	Supportive; experimental antivirals in the study	Supportive; ribavirin ineffective; no antivirals
Prevention	Vector control; Dengvaxia® in select countries	Live-attenuated vaccine (e.g., SA 14–14-2); vector control	No vaccine; mosquito control and personal protection	No vaccine; vector control and surveillance

Impact of vaccination against JE in endemic countries

(Letson and the Vaccine Global Impact Assessment Team, PLOS Neglected Tropical Diseases 2024)

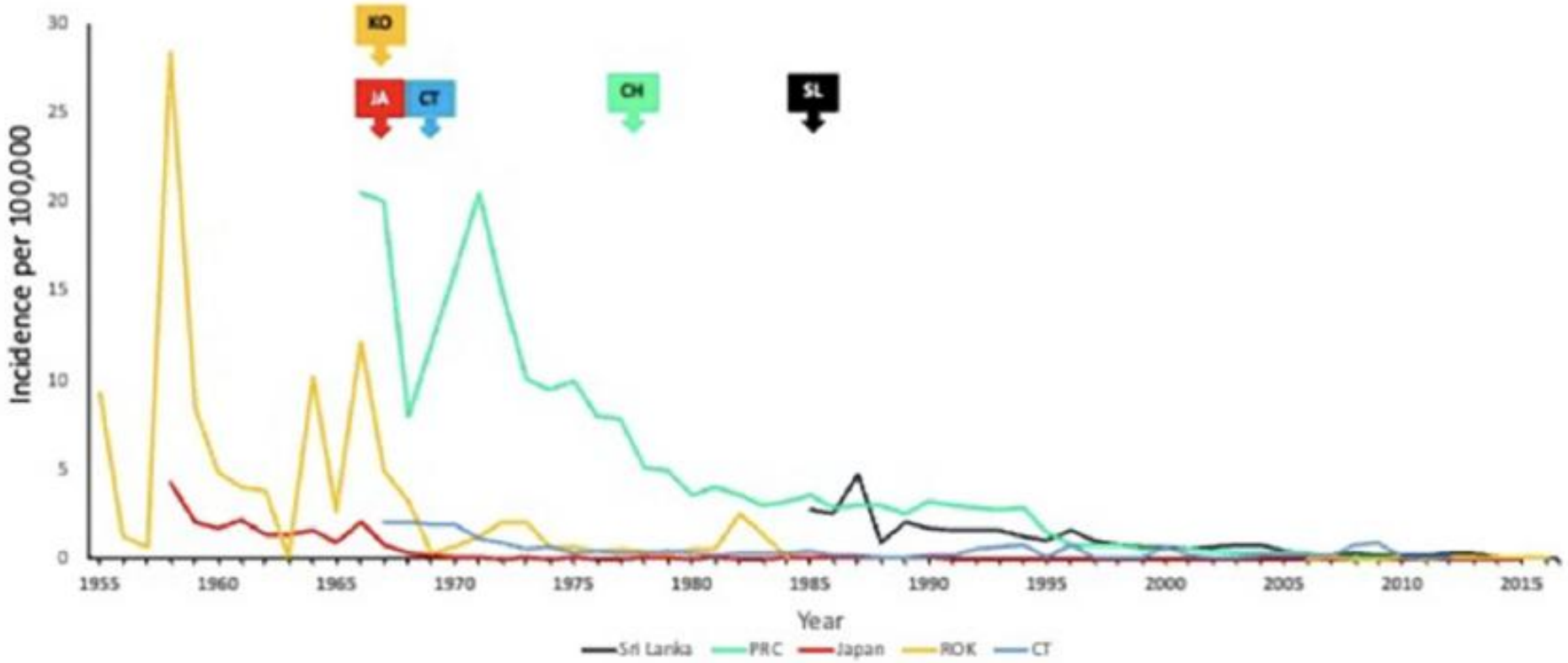


Fig 1. All-age JE incidence in Sri Lanka (SL), People's Republic of China (CH), Japan (JA), Chinese Taipei (CT), and the Republic of Korea (KO) by year. JE vaccine introduction noted by arrow.

Tick borne encephalitis (TBE)

- Flavivirus / three subtypes
- TBE is most often manifested as a two-phased illness
- First phase is associated with symptoms like fever, fatigue, headache muscular ache and nausea
- 2nd phase involves the neurological system with symptoms of meningitis and/or encephalitis
- Effective vaccination
- Case management

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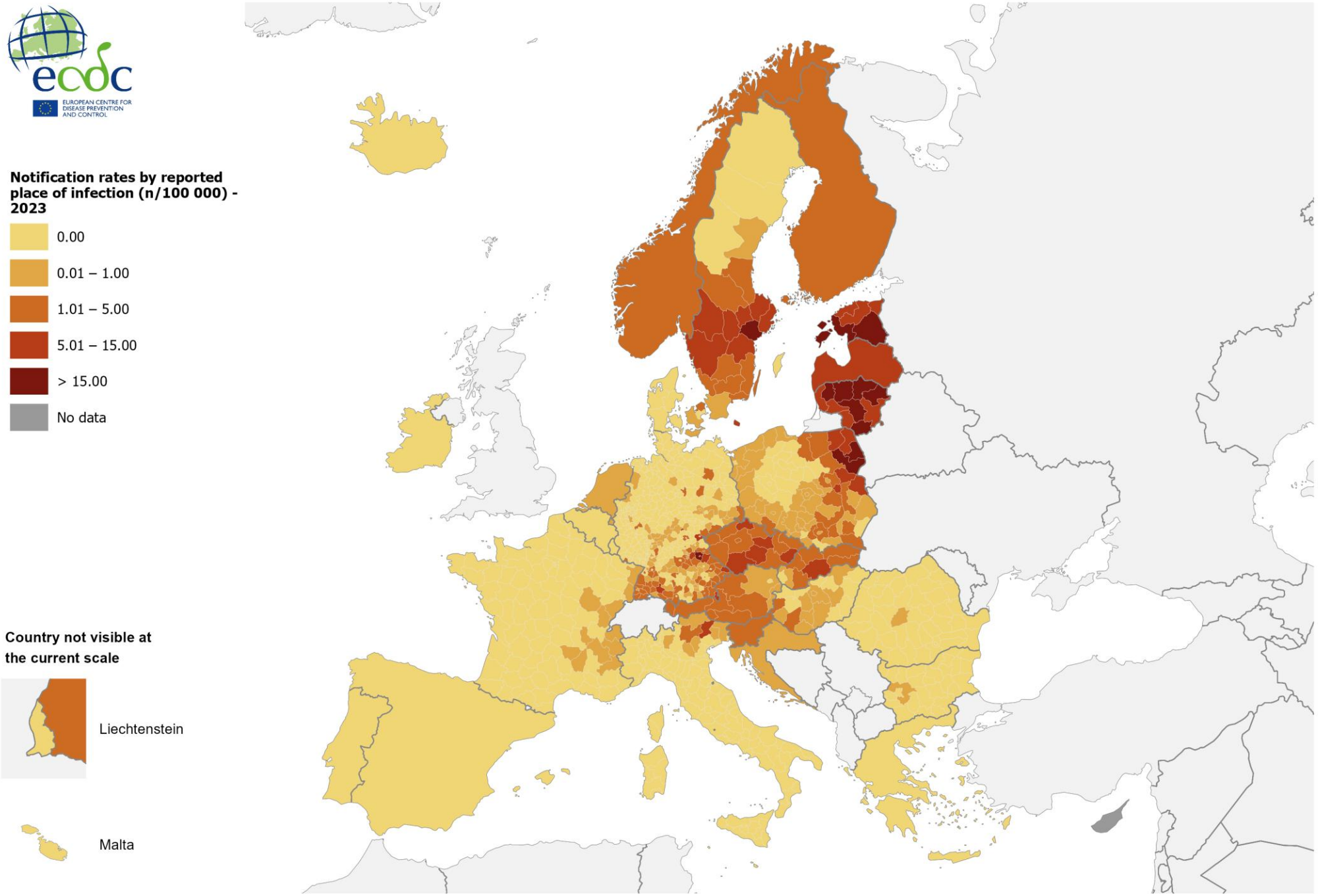
TBE

TBE: public health challenge in Europe

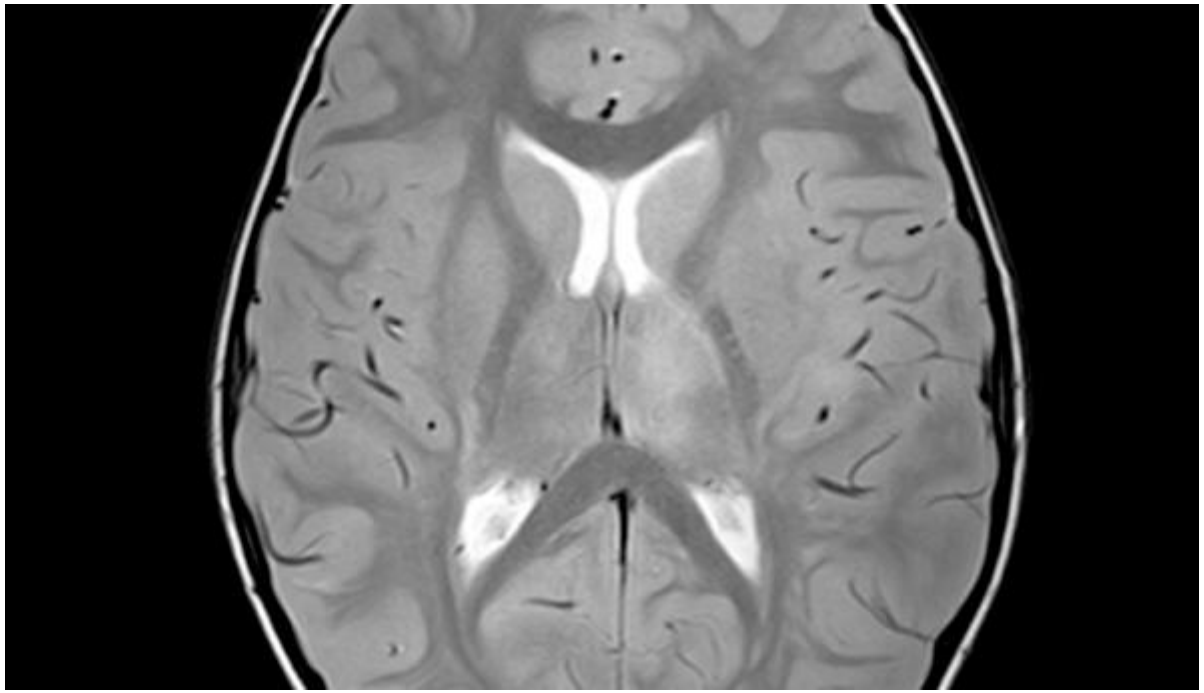
Cases of TBE in all endemic regions of Europe increased by almost 400% in the last 30 years



Administrative boundaries: ©EuroGeographics ©UN-FAO. The boundaries and names shown on this map do not imply official endorsement or acceptance by the European Union. Map produced by ECDC on 09 April 2025.

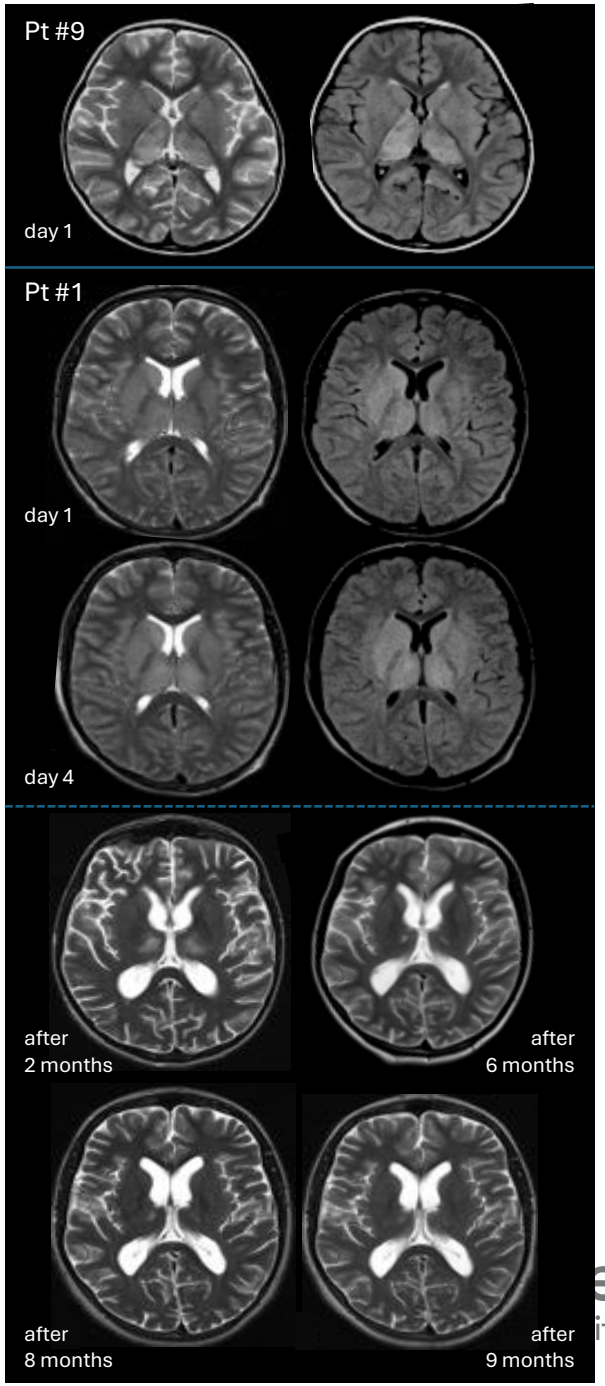
Case 4- History

- A 13 year old girl presented to the outpatient department with a 2-day history of fever up to 40°C, severe headache, nausea.
- The week before she had a 5 day episode of fever + malaise.
- One day after admission she became unconcious, was transferred to the ICU, ventilated.
- CSF: Leukocytes 227 cells/ul
- EEG: marked diffus delta activity



Imaging in tick-borne encephalitis

Diagnosis:TBE/Japanese Encephalitis



vStülpnagel EPNJ, 2016

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DENGUE-Virus encephalitis definition criteria

Soares *et al*. 2011[8]	Carod-Artal *et al*. 2013[9]
1. Presence of fever 2. Acute signs of cerebral involvement such as altered consciousness or personality and/or seizures, and/or focal neurological signs 3. Reactive IgM DEN antibody, NS1 antigen or positive DEN PCR on serum and/or CSF 4. Exclusion of other causes of viral encephalitis and encephalopathy	Dengue diagnostic tests were highly suggestive of or confirming acute DENV infection as recommended by WHO[a] for clinical category of DEN encephalitis, and to fulfil all of the following: 1. CNS involvement[b] 2. Presence of DEN virus RNA, or NS1 antigen in CSF 3. CSF pleocytosis without other neuroinvasive pathogens

a. Highly suggestive DEN: IgM-positive in one serum sample; or IgG-positive in one serum sample with haemagglutination inhibition titre of 1280 or greater.
Confirmed DEN is defined by one of the following: PCR-positive; virus culture-positive; IgM seroconversion in paired serum samples; IgM seroconversion in paired serum samples or four-times IgG titre increase in paired serum samples.
b. CNS involvement: At least one of the following: impaired conscious (for children < 6 years, Blantyre coma score ≤ 4; for those older than 5 years, GCS ≤14), neck stiffness, focal neurological signs or seizures

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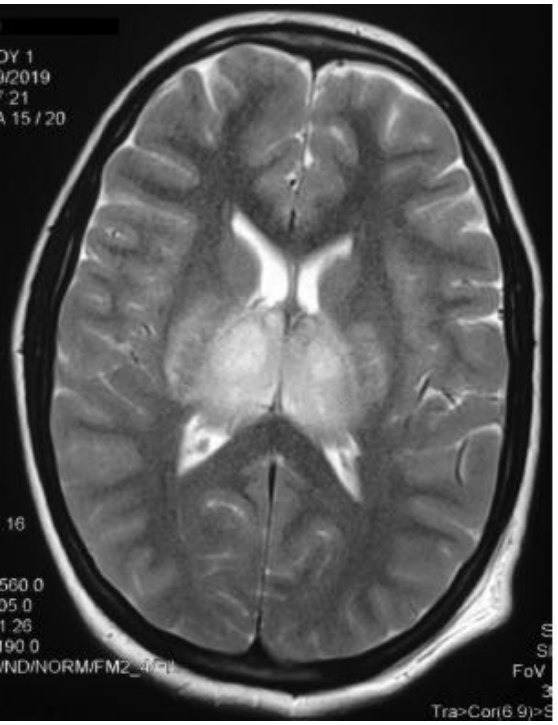
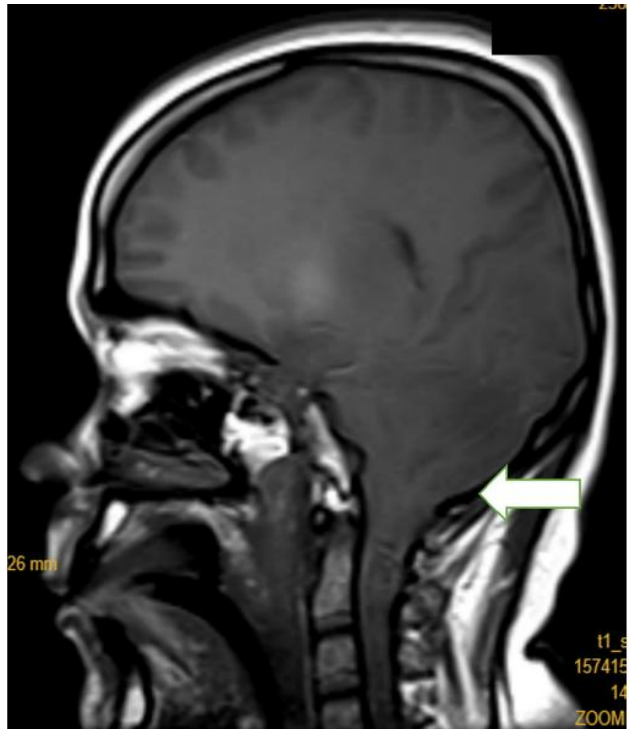
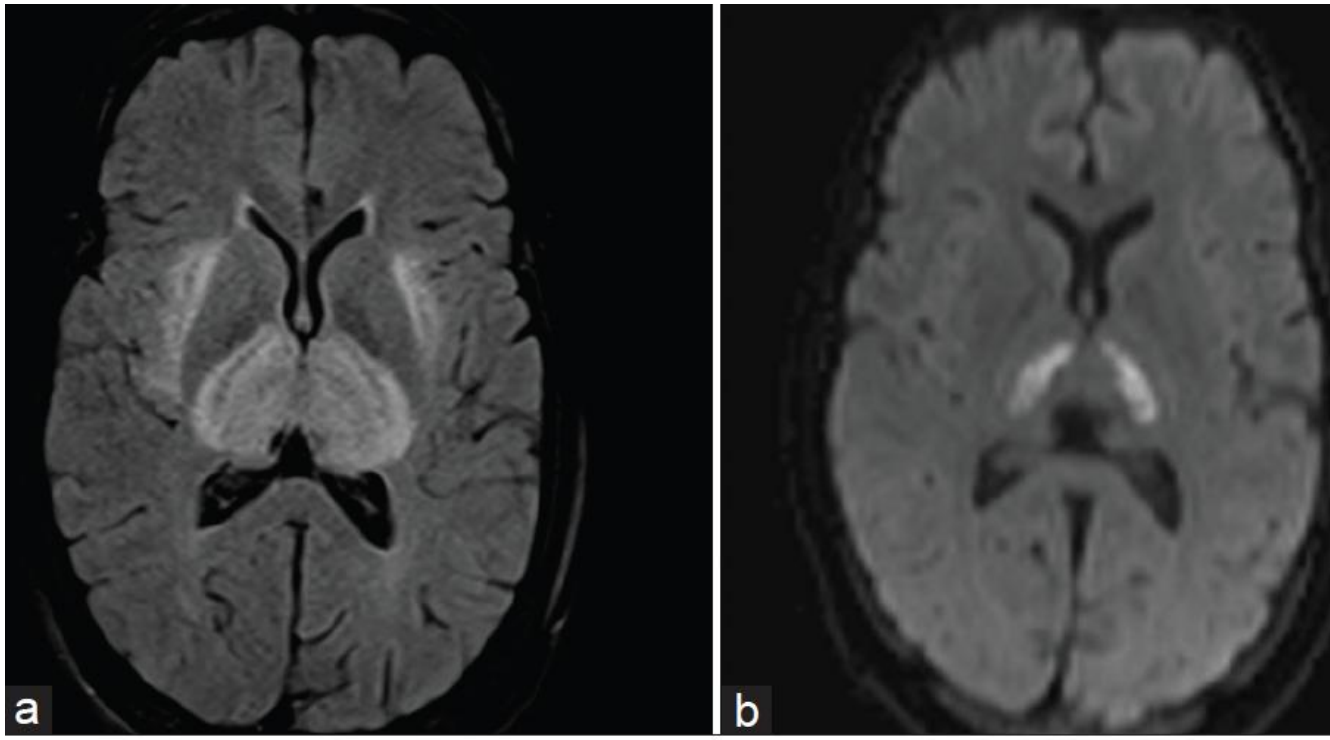
MRI in Dengue-virus encephalitis (1)



cMRI: central haemorrhages in bil. thalamii.



Brain herniation with marked crowding and cerebellar tonsil herniation



FLAIR with symmetrical areas of signal alteration involving insular regions, thalami, with DWI showing corresponding affected areas.

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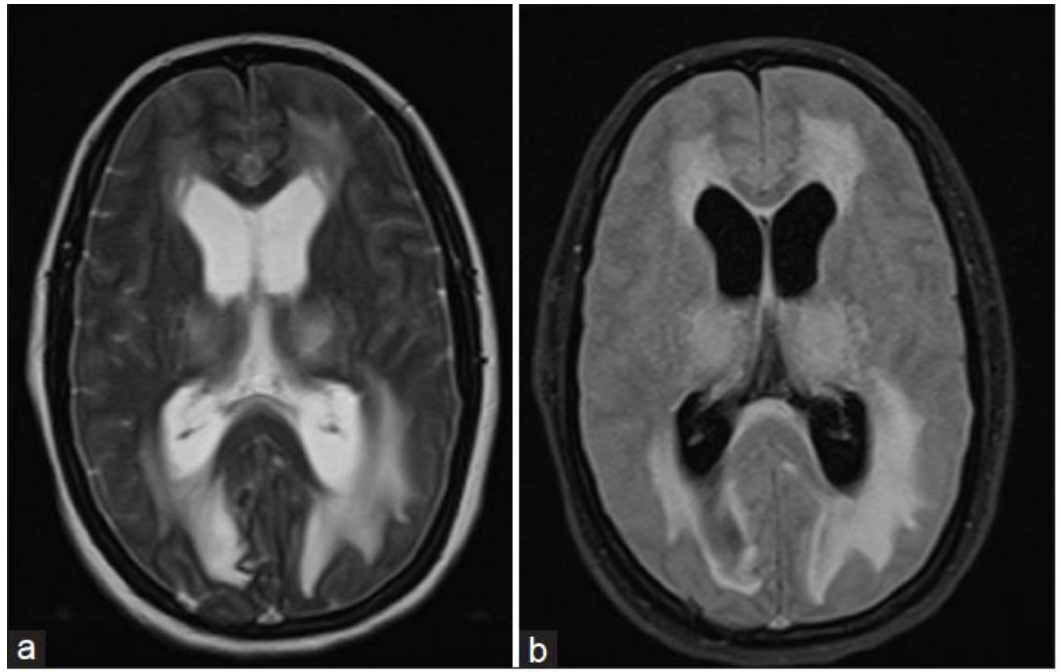
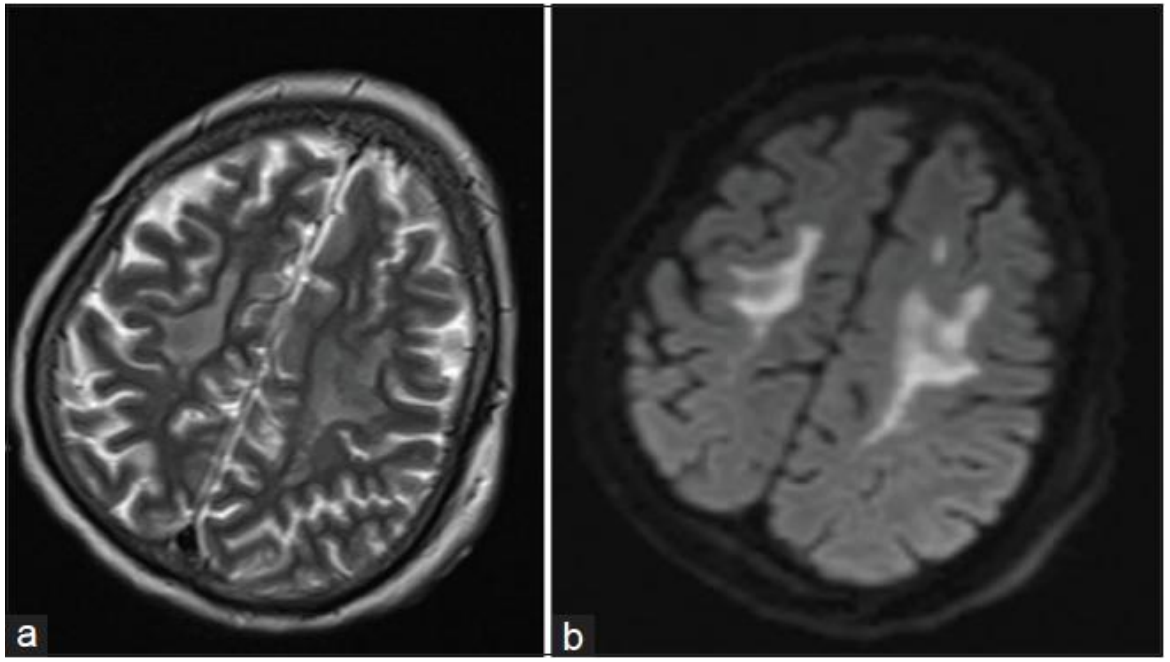
MRI in Dengue encephalitis (2)



a. Signal alteration in bilateral cerebral hemispheres, ventricular dilatation. b. FLAIR showing corresponding hyperintense lesions .



a. T2W showing areas of signal alteration in subcortical and adjacent deep white matter in bilateral frontal parietal regions, b. T2W FLAIR showing corresponding hyperintense lesion.

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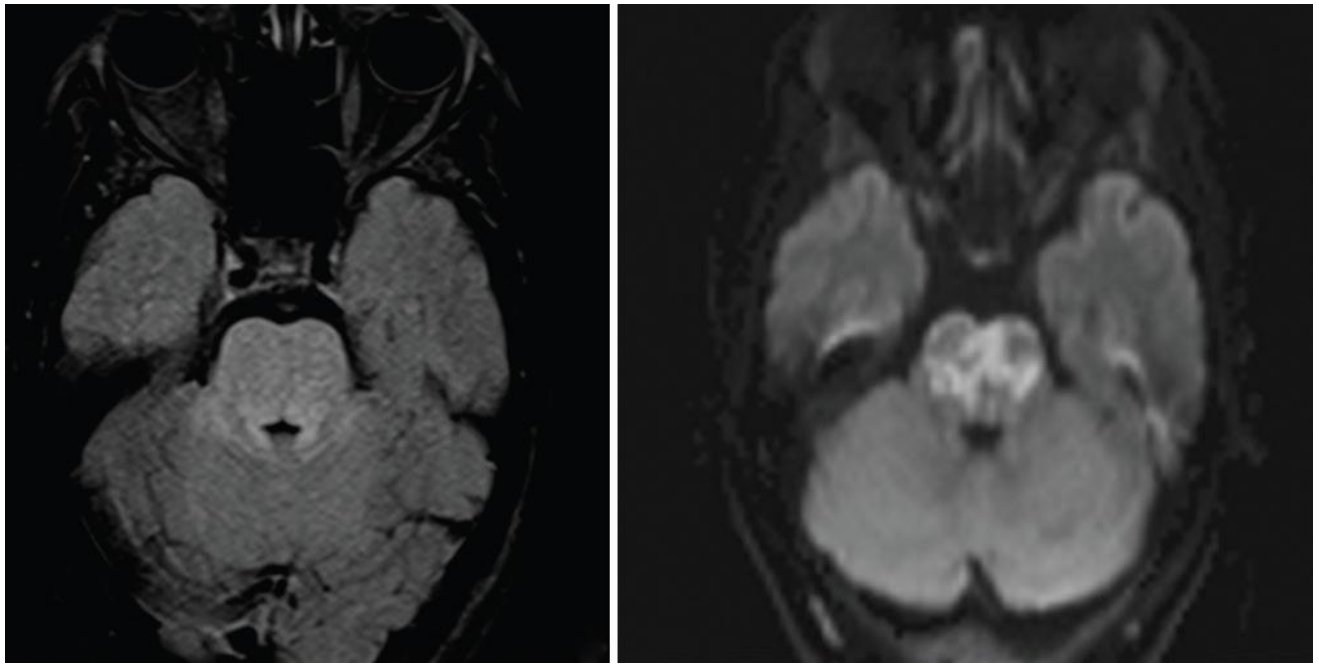
MRI in Dengue encephalitis (3)



T2 FLAIR showing near symmetrical areas of signal alteration involving brainstem, b. DWI showing corresponding hyperintense lesion .

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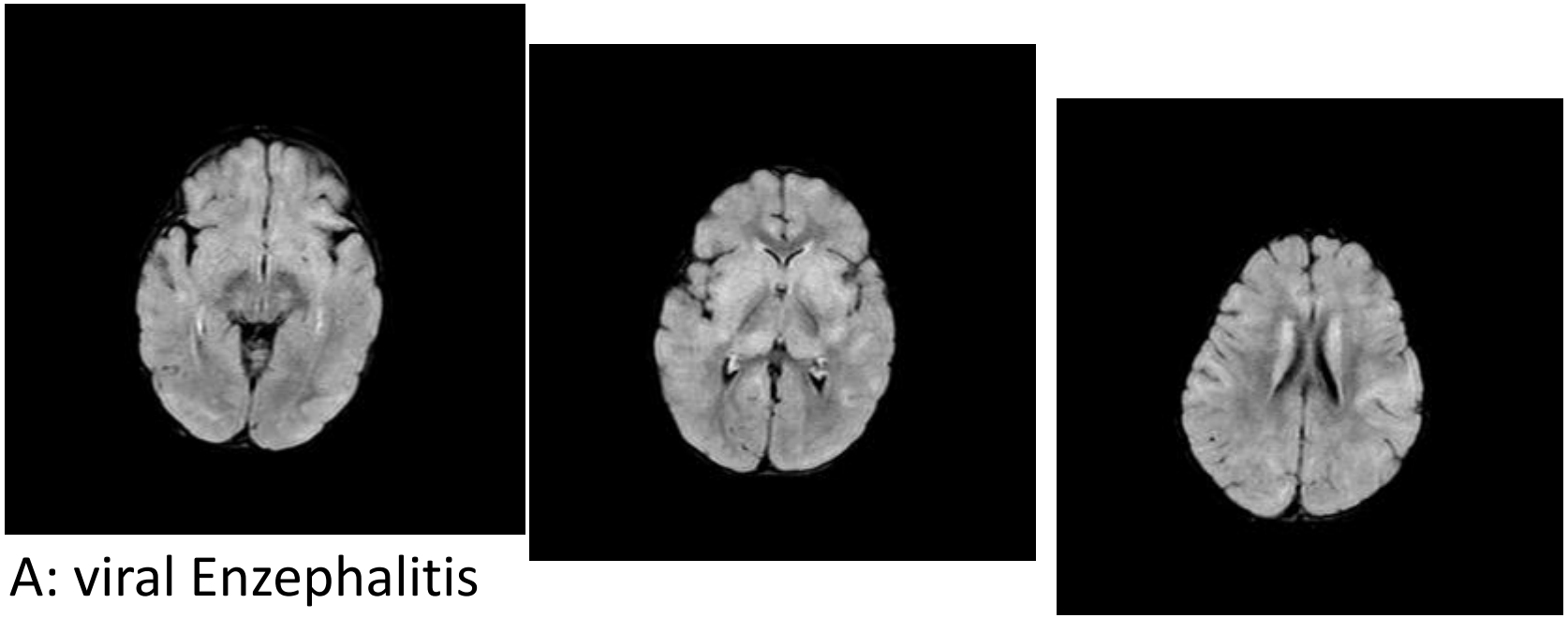
Quiz 1: 14 mo old child with? MOGAD-ADEM (B)

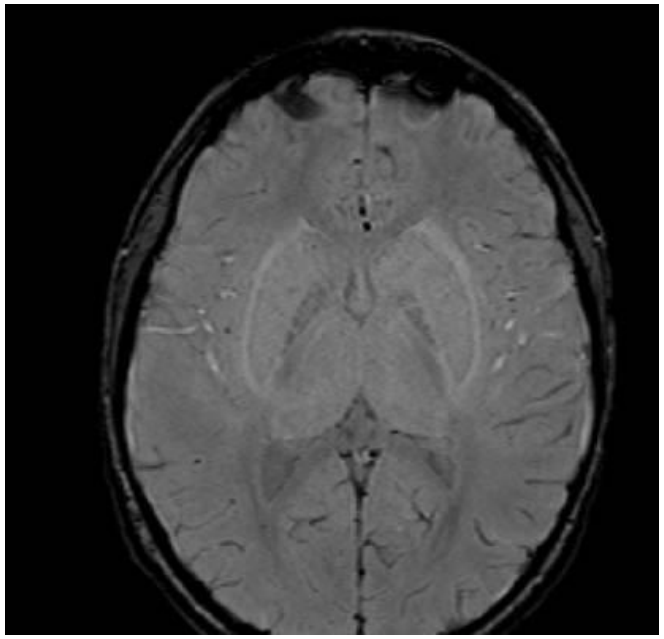
- fever, diarrhea
- somnolent, focal seizures
- CSF 49 cells/ul, EEG: generalized slowing,

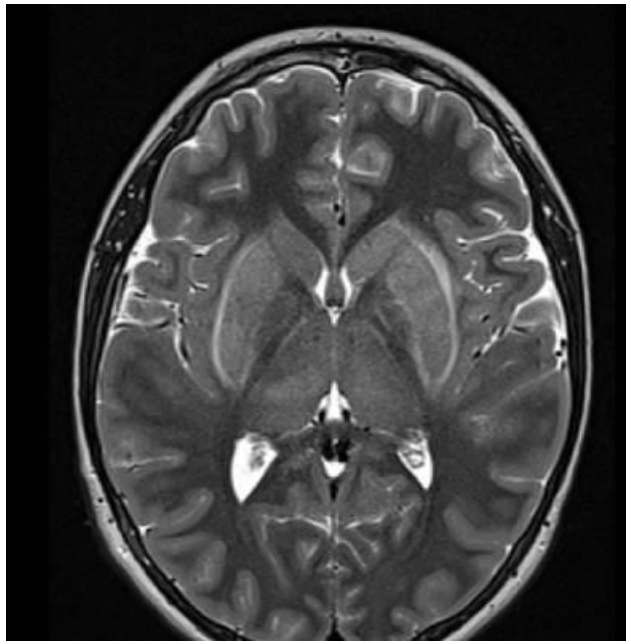


A: viral Enzephalitis
B: MOGAD-ADEM
C: ANE
D: Mitochondriale disease
E: Rota-virus encephalitis

Quiz 2: TBE/FSME (A)

- 9 yo boy from Austria with a fever episode and malaise 5 days ago,
- increasing tiredness, hemiparesis right arm and leg,
- CSF: 86 cells/ul, high protein, EEG generalized slowing !





A: TBE/FSME,

B: ADEM,

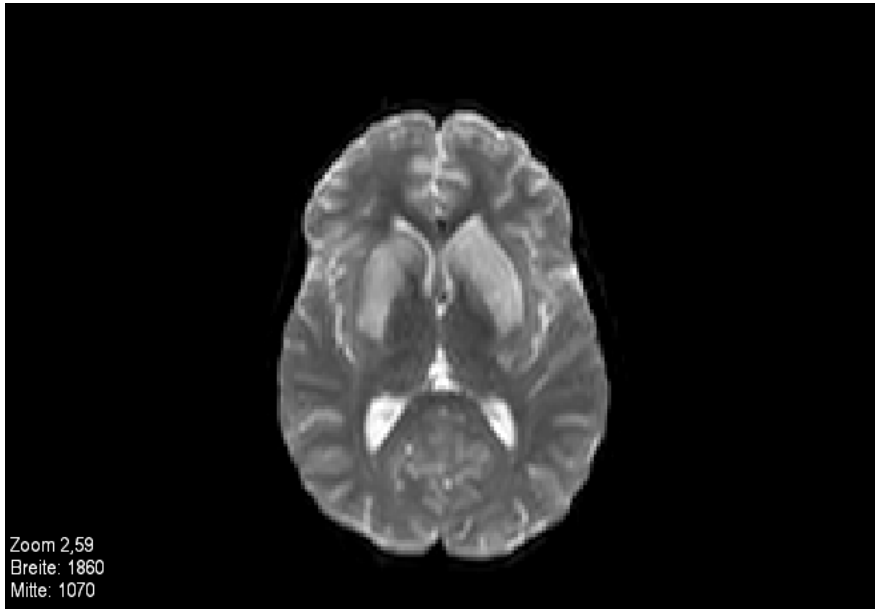
C: Biotin-responsive- basalganglia disease,

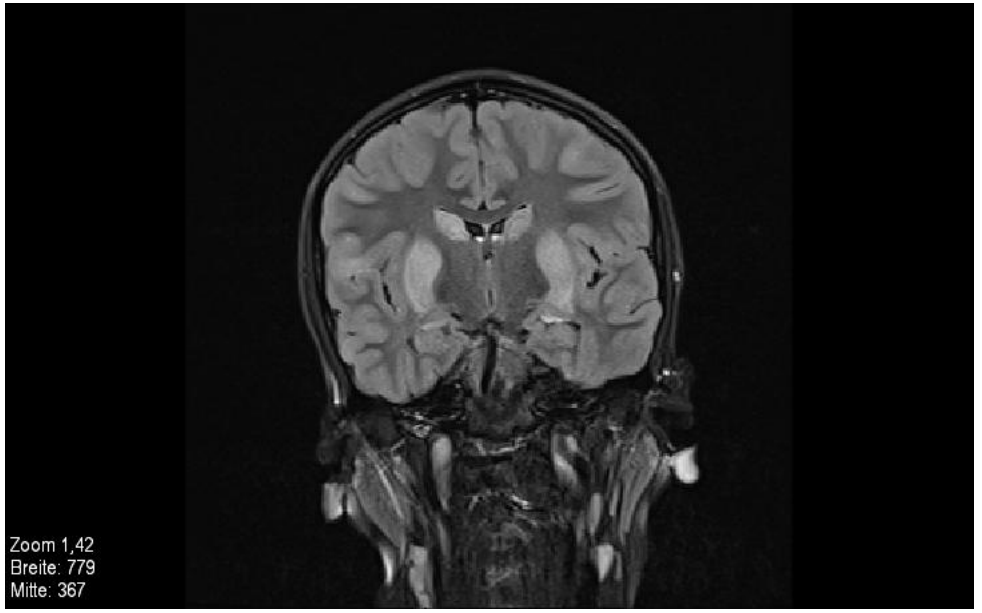
D: ANE,

E: Mitochondriale Erkrankung.

Quiz 3: Mycoplasma- associated Encephalitis (B)

- Young child with a fever episode and cough,
- encephalopathy with increasing inability to move
- increased muscle tone with rigor





A: TBE/FSME

B: Mycoplasma-associated encephalitis

C: Biotin-responsive- Basalganglia disease,

D: Dengue-virus encephalitis

E: Leigh-disease.

Summary

- Neuroborreliosis: majority of children has common clinical presentations but be aware of colibris.
- Adhere to the diagnostic criteria for possible and definite NB.
- Endemic disease in Asia and Africa such as West-Nile Virus and Dengue-Virus are emerging in other parts of the world.
- Neurological complications occur in a small proportion but are associated with significant morbiditynand mortalitiy.
- MR-imaging indicates indirect mechanisms leading to cytotoxic injury rather than direct invasion!