Pediatric Multiple Sclerosis:
Is it just an earlier onset ??

Amr Hassan, M.D.

Lecturer of Neurology - Cairo University

Alexandria - June 2014

Pediatric Multiple Sclerosis

Is it just an earlier onset ??

Agenda
Pediatric Multiple Sclerosis

- Definition.
- Epidemiology .
- Risk factors.
- Pathophysiology .
- Clinical features and differential diagnosis.
- Investigations
- Treatment.

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Definition

- The term “ pediatric MS ” is applied to children with MS (< 10 years of age) and adolescents (< 18 years of age).

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Epidemiology

- **2.2% to 5%** of all MS cases.
- Some MS referral centers report that up to **10%** of their patients with MS experienced symptom onset prior to age **18 years**.

Epidemiology
Age

- Within the pediatric age group, the incidence is highest in those between 13 and 16 years of age.
- A small, but important, subgroup is younger than 10 years of age.

Epidemiology
Gender

- However, for those < 10 years of age:

  Female-to-male ratio ranges from 0.8:1 in children younger than 6 years of age to 1.6:1 in patients between 6 and 10 years of age

Banwell B, Ghezzi A, Bar-Or A, Mikaeloff Y, Tardieu M. Multiple sclerosis in children: clinical diagnosis, therapeutic strategies, and future directions. *Lancet Neurology*. 2007;6(10):887–902.

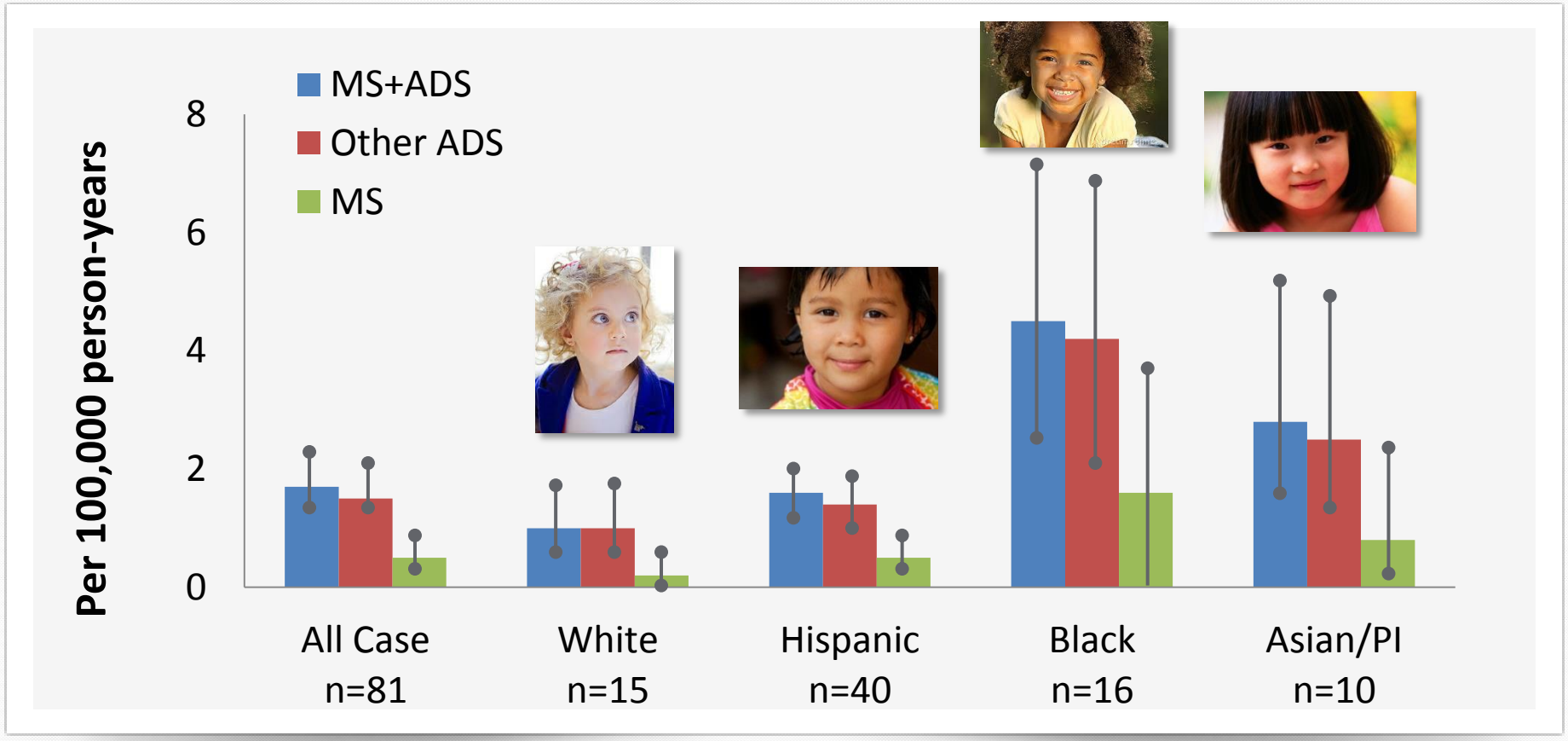
Epidemiology
Gender

- In subjects >10 years of age and adolescents:

  Females predominate from 2.1:1 to 3:1, respectively.

Banwell B, Ghezzi A, Bar-Or A, Mikaeloff Y, Tardieu M. Multiple sclerosis in children: clinical diagnosis, therapeutic strategies, and future directions. *Lancet Neurology*. 2007;6(10):887–902.

Epidemiology
Race



Neurology. Sep 20, 2011; 77(12): 1143–1148.

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Risk Factors

- A few studies have evaluated genetic risk factors in pediatric MS.
- The US Pediatric MS Network has also reported that HLA-DRB1, as in adult MS, may be a risk factor for pediatric MS.

Risk Factors

Neurology. 2013 Feb 5;80(6):548-52. doi: 10.1212/WNL.0b013e3182815 4f3. Epub 2013 Jan 30.

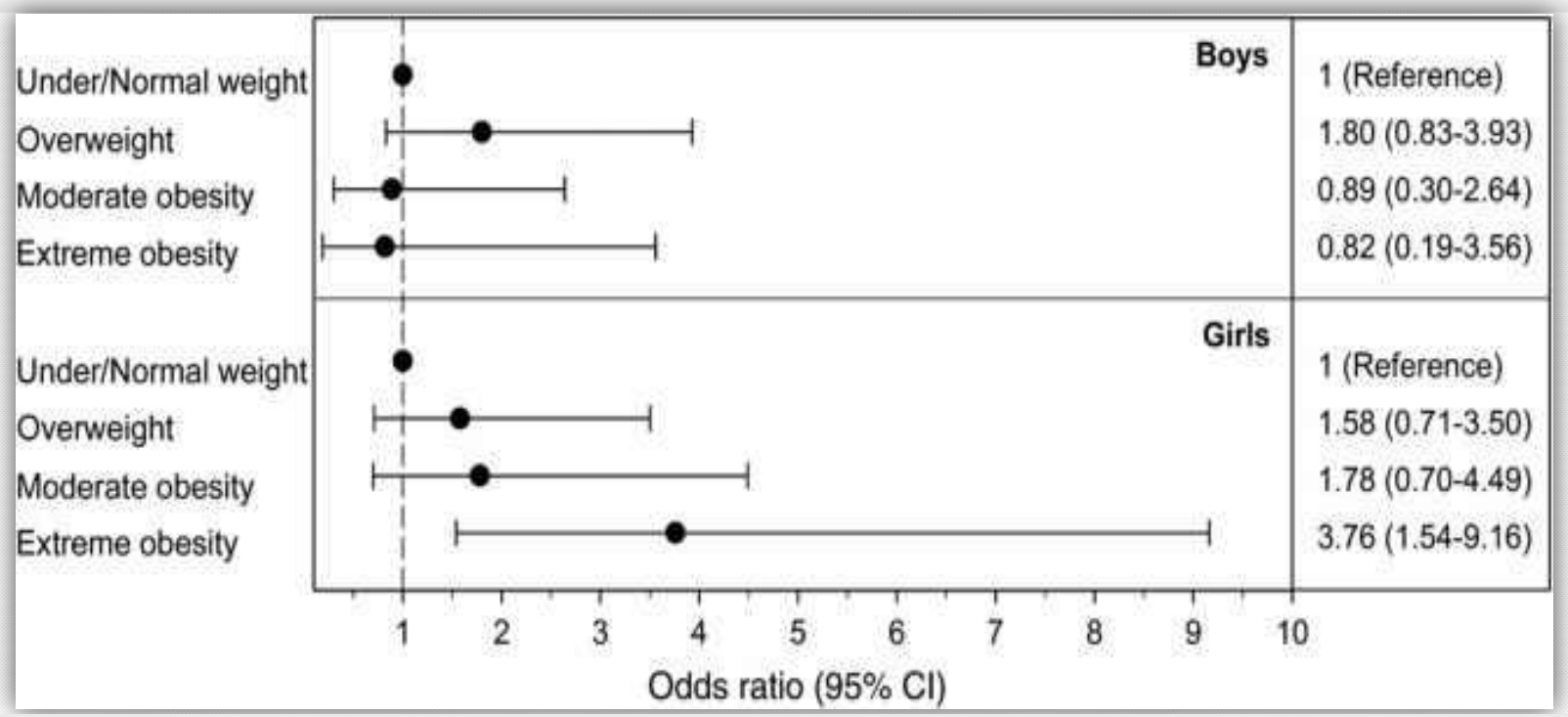
Childhood obesity and risk of pediatric multiple sclerosis and clinically isolated syndrome.

Langer-Gould A[1], Brara SM, Beaber BE, Koebnick C.

Results: Obesity was associated with a significantly increased risk of MS/CIS in girls (p = 0.005 for trend) but not in boys (p = 0.93).

Conclusion: childhood obesity epidemic is likely to lead to increased morbidity from MS/CIS, particularly in adolescent girls.

Risk Factors



Association between weight class and pediatric multiple sclerosis/clinically isolated syndrome by sex Depicted are the adjusted odds ratios (OR) and 95% confidence intervals (CI) of pediatric multiple sclerosis and clinically isolated syndrome (MS/CIS) with increasing weight class compared with normal/underweight children (reference category) stratified by sex. Increasing weight class was associated with increasingly higher OR for MS/CIS among girls (*p* for trend <0.005) but not boys (*p* for trend 0.93). OR are adjusted for age at onset and race/ethnicity.

Risk Factors

- Interestingly, the risk of childhood-onset MS as related to exposure to **passive smoking.**
- The relative risk for a first episode of MS was found to be over twice that in the control population and was even higher in those with prolonged exposure (≥10 years).

Mikaeloff Y, Caridade G, Assi S, Tardieu M, Suissa S. Hepatitis B vaccine and risk of relapse after a first childhood episode of CNS inflammatory demyelination. Brain. 2007;130(part 4):1105–1110.

Risk Factors

Neurology. 2006 Dec 12;67(11):2063-5.

High seroprevalence of Epstein-Barr virus in children with multiple sclerosis.

Pohl D[1], Krone B, Rostasy K, Kahler E, Brunner E, Lehnert M, Wagner HJ, Gärtner J, Hanefeld F.

Author information

Abstract

We studied seroprevalence and concentrations of Epstein-Barr virus (EBV) antibodies in 147 pediatric patients with multiple sclerosis (MS) and paired controls. The children with MS showed a near-complete seropositivity for EBV antibody against virus capsid antigen (98.6% vs 72.1% in controls, p = 0.001) but did not display serologic evidence for a recent EBV infection. EBV antibody concentrations of pediatric patients with MS were significantly higher vs controls.

Risk Factors

Neurology. 2011 Jun 7;76(23):1989-95. doi: 10.1212/WNL.0b013e31821e552a.

Common viruses associated with lower pediatric multiple sclerosis risk.

Abstract

BACKGROUND: Because common viruses are encountered during childhood, pediatric multiple sclerosis (MS) offers a unique opportunity to investigate the influence of these viruses on disease susceptibility and the interactions between seroprevalence and select HLA genotypes. We studied seroprevalence for Epstein-Barr virus (EBV), cytomegalovirus (CMV), and herpes simplex virus (HSV) type 1 and HLA-DRB1*1501/1503 status as predictors of pediatric MS.

METHODS: This was a retrospective analysis of prospectively collected demographic, clinical, and biologic data in subjects up to 18 years of age with early MS, control subjects seen at the same regional referral pediatric MS clinics, and additional healthy pediatric control subjects.

RESULTS: Patients with early pediatric MS (n=189) and pediatric control subjects (n=66) were tested. Epstein-Barr nuclear antigen-1 seropositivity was associated with an increased odds of MS (odds ratio [OR] 3.78, 95% confidence interval [CI] 1.52-9.38, p=0.004) in analyses adjusted for age, sex, race, ethnicity, and HLA-DRB1*1501/1503 status. In multivariate analyses including EBV status, a remote infection with CMV (OR 0.27, 95% CI 0.11-0.67, p=0.004) was associated with a lower risk of developing MS. Although a remote infection with HSV-1 was not associated with an increased odds of MS, a strong interaction was found between HSV-1 status and HLA-DRB1 in predicting MS (p<0.001). HSV-1 was associated with an

CONCLUSIONS: These findings suggest that some infections with common viruses may in fact lower MS susceptibility. If this is confirmed, the pathways for risk modification remain to be elucidated.

Risk Factors

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ORIGINAL ARTICLE

Hepatitis B Vaccination and the Risk of Multiple Sclerosis

Alberto Ascherio, M.D., Dr.P.H., Shumin M. Zhang, M.D., Sc.D., Miguel A. Hernán, M.D., Dr.P.H., Michael J. Olek, M.D., Paul M. Coplan, Sc.D., Kimberly Brodovicz, M.P.H., and Alexander M. Walker, M.D., Dr.P.H.

N Engl J Med 2001; 344:327-332 | February 1, 2001 | DOI: 10.1056/NEJM200102013440502

- **Conclusions: These results indicate no association between hepatitis B vaccination and the development of multiple sclerosis**

Risk Factors

Ann Neurol. 2010 May;67(5):618-24. doi: 10.1002/ana.21972.

Vitamin D status is associated with relapse rate in pediatric-onset multiple sclerosis.

Mowry EM[1], Krupp LB, Milazzo M, Chabas D, Strober JB, Belman AL, McDonald JC, Oksenberg JR, Bacchetti P, Waubant E.

- **Conclusion:**
  Lower serum 25-hydroxyvitamin D(3) levels are associated with a subsequent relapse rate in pediatric-onset MS or CIS.

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Pathophysiology

- **Axonal damage is typically limited**
- **Dense accumulation of lymphocytes and macrophages in a prominent perivascular distribution, with rare B cells.**

Pathophysiology

- Anti–myelin oligodendrocyte glycoprotein (MOG) and anti–myelin basic protein (MBP) have been studied in both adults and children.
- In children, these anti-myelin antibodies seem to be associated with encephalopathy at onset.

Pathophysiology

- Lesser intrathecal antibody production (OCBs or an elevated IgG index).
- Higher percentage of neutrophils in their CSF.

Prominent activation of the innate immune response, as opposed to the typical activation of the adaptive response seen in older patients.

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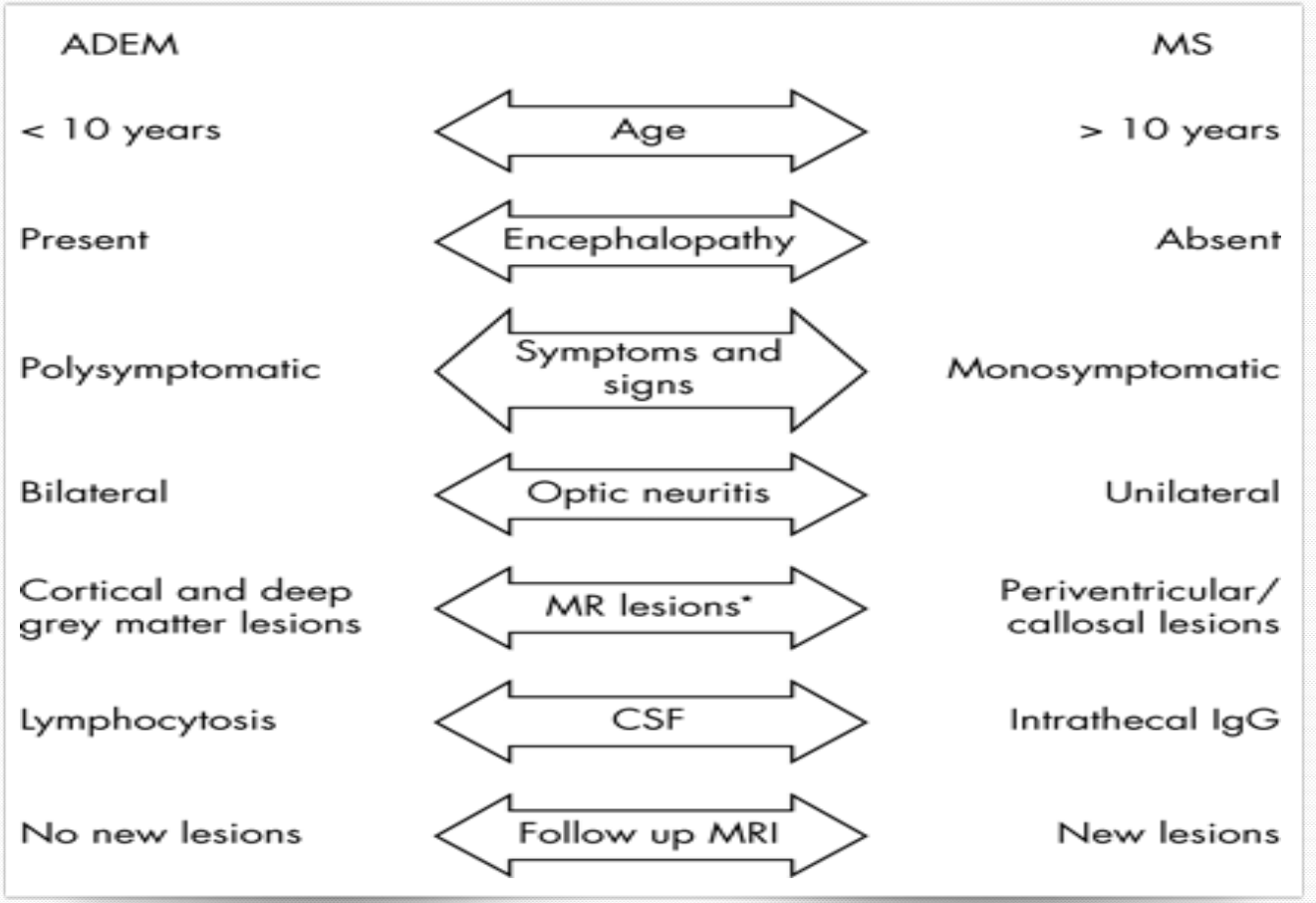
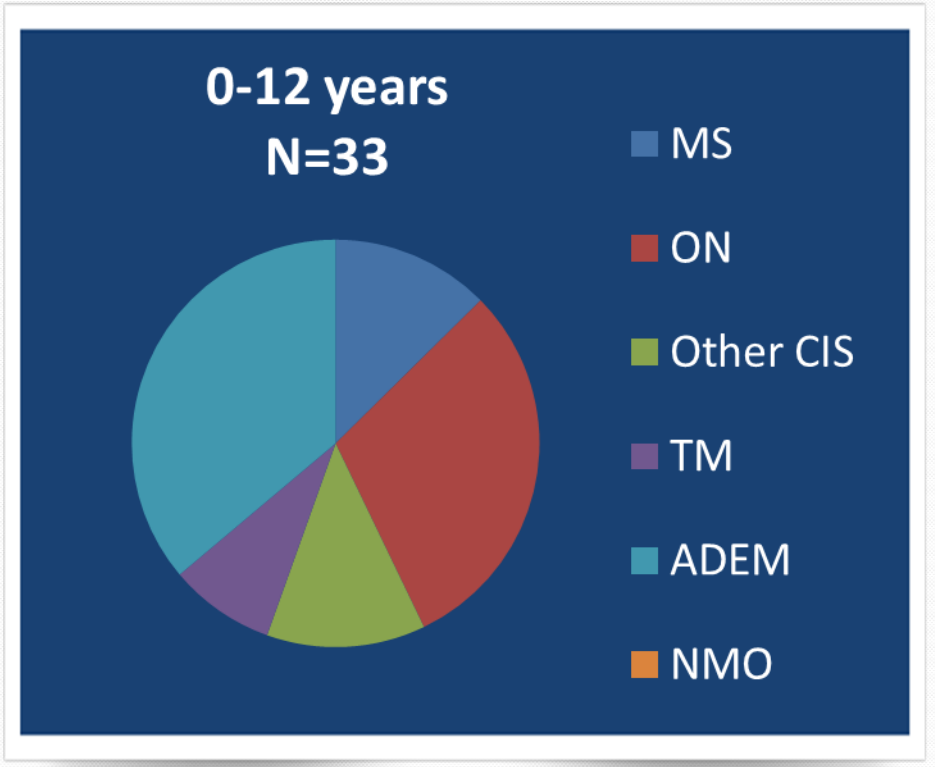
Clinical Features and Differential Diagnosis

- Polysymptomatic (50–70%)
- Monosymptomatic (30–50%)
- Approximately 15 to 20% of pediatric MS patients, most aged <11 years, present with encephalopathy and multifocal neurological deficits difficult to distinguish from acute disseminated encephalomyelitis (ADEM).

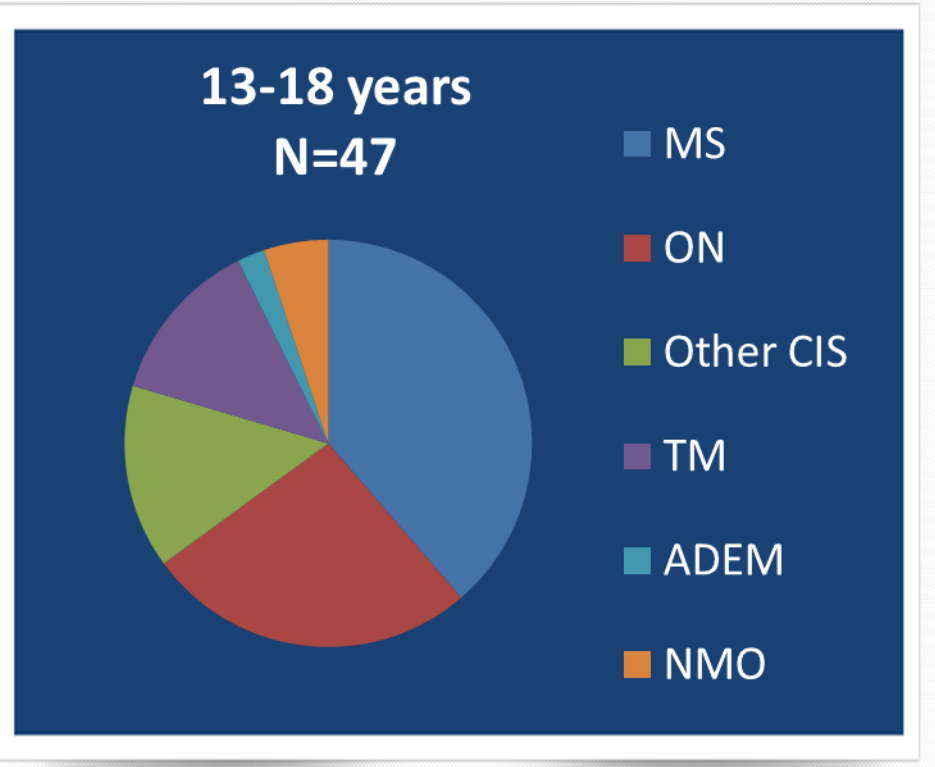
ADEM vs MS


ADEM
MS
< 10 years
Age
> 10 years
Present
Encephalopathy
Absent
Polysymptomatic
Symptoms and signs
Monosymptomatic
Bilateral
Optic neuritis
Unilateral
Cortical and deep grey matter lesions
MR lesions*
Periventricular/ callosal lesions
Lymphocytosis
CSF
Intrathecal IgG
No new lesions
Follow up MRI
New lesions

Clinical Features and Differential Diagnosis



42% Female



68% Female

Neurology. Sep 20, 2011; 77(12): 1143–1148.

Clinical Features and Differential Diagnosis

Pediatric Clinically Isolated Syndrome (CIS)

- A monofocal or polyfocal clinical neurological event with presumed inflammatory demyelinating cause.
- Absence of encephalopathy that cannot be explained by fever.
- Absence of previous clinical history of CNS demyelinating disease.
- Other etiologies have been excluded.
- The most recent 2010 revised MS McDonald criteria on a baseline MRI are not met.

Autoimmune Dis. 2013; 2013: 673947.

Clinical Features and Differential Diagnosis

Monophasic ADEM

- A first polyfocal clinical neurological event with presumed inflammatory cause.
- Encephalopathy that cannot be explained by fever is present.
- No new symptoms, signs, or MRI findings after three months of the incident ADEM.

Multiphasic ADEM

- A new event of ADEM three months or more after the initial event.
- Can be associated with new or reemergence of prior clinical and MRI findings.
- Timing in relation to steroids is no longer relevant.

Autoimmune Dis. 2013; 2013: 673947.

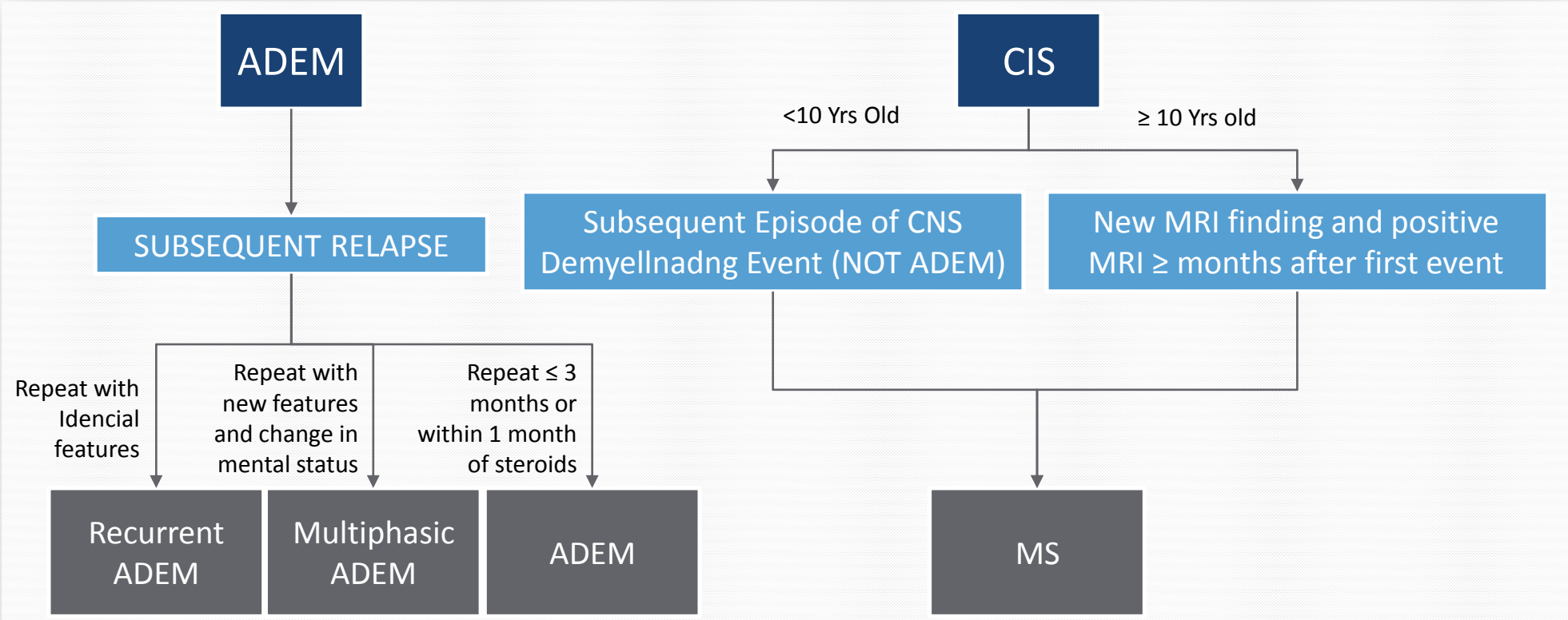
Clinical Features and Differential Diagnosis

Pediatric Multiple Sclerosis

- Two or more clinical events separated by more than 30 days and involving more than one area of the CNS.
- A single clinical event plus a baseline MRI evidence for DIS and DIT that meets the recent 2010 revised McDonald criteria.
- ADEM followed more than three months later by a nonencephalopathic clinical event with new lesions on brain MRI consistent with MS.

Autoimmune Dis. 2013; 2013: 673947.

ADEM vs MS



Flow chart/decision tree for the diagnosis of acute disseminated enceph-alomyelitis (ADEM), recurrent ADEM, multiphasic ADEM, and pediatric multiple sclerosis.Amna Al-Futaisi. Oman Med J. 2007 October;22(3):11-15.

Optic Neuritis

- **The risk of developing MS after having an isolated episode of ON in childhood has been reported to range between 10% and 56%.**

Bigi S, Banwell B. Pediatric multiple sclerosis. Journal of Child Neurology. 2012;27(11):1378–1383.

Optic Neuritis

Neurology. 2006 Jul 25;67(2):258-62.

The clinical features, MRI findings, and outcome of optic neuritis in children.

Wilejto M[1], Shroff M, Buncic JR, Kennedy J, Goia C, Banwell B.

Results: Records of 36 children.

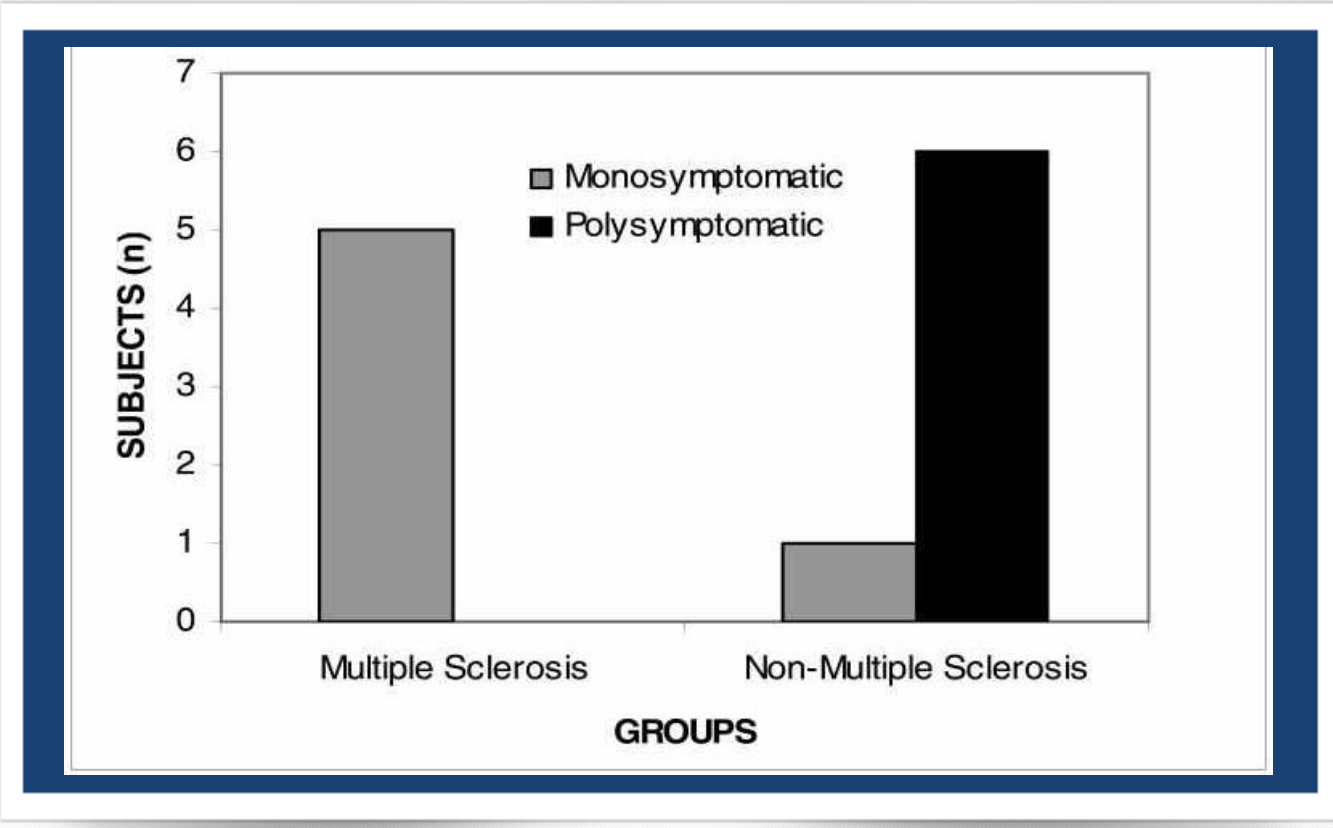
- ON was unilateral in 58% and bilateral in 42%.
- To date, 13 children (36%) have been diagnosed with MS and 1 has Devic disease.
- Bilateral ON was more likely to be associated with MS outcome (p = 0.03).
- All 13 children with MS had white matter lesions on brain MRI. None of the children with a normal brain MRI have developed MS to date.

Optic Neuritis

- Alper and Wang reported that **23%** of pediatric patients with ON eventually developed MS within 6 years in their study and found a strong correlation between a normal MRI and a monophasic clinical presentation.
- **For example**, MS was diagnosed in 42% of children with an abnormal MRI, whereas 93% of children with normal MRIs remained relapse-free.

Alper G, Wang L. Demyelinating optic neuritis in children. Journal of Child Neurology. 2009;24(1):45–48.

Patients with abnormal MRI



Clinical outcome in patients only with abnormal magnetic resonance imaging (MRI) of brain according to monosyptomatic or polysymptomatic presentation (p=0.015)

Alper G, Wang L. Demyelinating optic neuritis in children. Journal of Child Neurology. 2009;24(1):45–48.

Transverse Myelitis

In the Canadian prospective study:

- **21% of the children with ADS presented with acute TM.**
- **TM was the first clinical event in approximately 10% of children with MS .**

Transverse Myelitis

Neurology. 2007 May 1;68(18):1474-80.

Acute transverse myelitis in childhood: center-based analysis of 47 cases.

Pidcock FS[1], Krishnan C, Crawford TO, Salorio CF, Trovato M, Kerr DA.

Results:

- **The risk of MS developing in patients with isolated TM is low.**
- **Only one of 47 children with TM followed for a period of 8 years had MS**

ADEM

- Some studies have suggested that 18% to 29% of patients with ADEM as their first demyelinating attack progress to MS.

ADEM

J Child Neurol. 2010 Jun;25(6):681-8. doi: 10.1177/0883073809343320. Epub 2009 Oct 6.

Long-term prognosis of pediatric patients with relapsing acute disseminated encephalomyelitis.

Mar S[1], Lenox J, Benzinger T, Brown S, Noetzel M.

had relapses. The mean follow-up duration was 12.8 years for relapsing cases and 9.2 years for all patients with acute disseminated encephalomyelitis. The risk of developing relapses is 27% but the risk of developing multiple sclerosis from acute disseminated encephalomyelitis is low at 6%. All relapsing cases had a benign course on prolonged follow-up, in spite of multiple relapses in the first 3 years.

Cognitive Impairment

- Approximately one-third of children and adolescents with MS experience cognitive impairment.
- Defined as “having at least one-third of completed test scores falling ≥1 SD or more below published normative data”

Cognitive Impairment

J Child Neurol. Author manuscript; available in PMC May 13, 2013.
Published in final edited form as:
J Child Neurol. Jan 2013; 28(1): 102–107.
Published online Nov 15, 2012. doi: 10.1177/0883073812464816

PMCID: PMC3652651
NIHMSID: NIHMS465426

Cognitive Impairment Occurs in Children and Adolescents With Multiple Sclerosis: Results From a United States Network

Laura Julian, PhD,[1] Dana Serafin, BS,[2] Leigh Charvet, PhD,[2] Joseph Ackerson, PhD,[3] Ralph Benedict, PhD,[4] Ellen Braaten, PhD,[5] Tanya Brown, PhD,[6] Ellen O'Donnell, PhD,[5] Joy Parrish, PhD,[7] Thomas Preston, PhD,[8] Michael Zaccariello, PhD,[6] Anita Belman, MD,[2] Tanuja Chitnis, MD,[9] Mark Gorman, MD,[9] Jayne Ness, MD,[10] Marc Patterson, MD,[11] Moses Rodriguez, MD,[11] Emmanuelle Waubant, MD,[12] Bianca Weinstock-Guttman, MD,[4] Ann Yeh, MD,[4] and Lauren B. Krupp, MD[2], for the Network of Pediatric MS Centers of Excellence

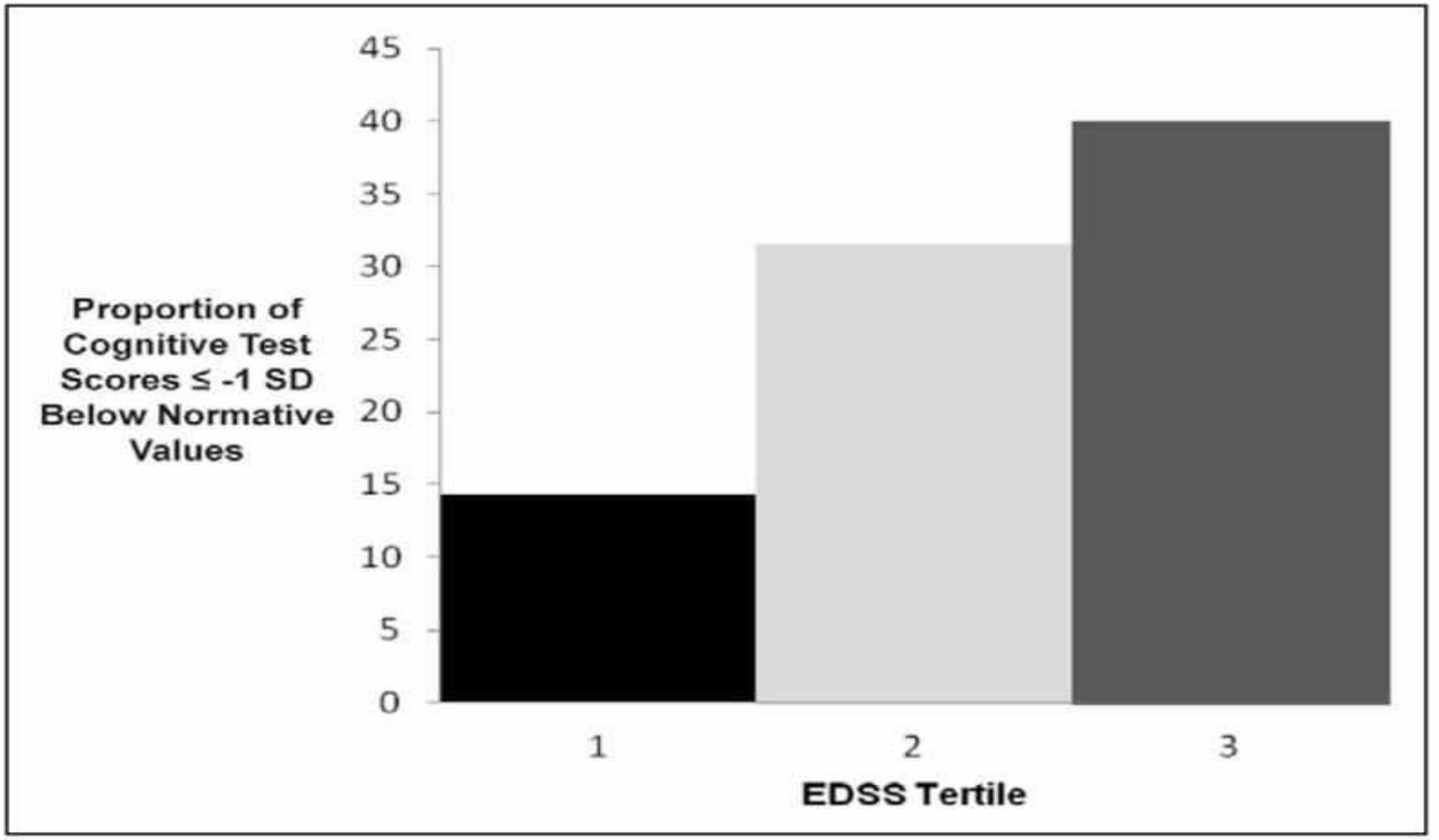
Cognitive Impairment

Abstract

Go to:

In the largest sample studied to date, we measured cognitive functioning in children and adolescents with pediatric multiple sclerosis (n =187) as well as those with clinically isolated syndrome (n =44). Participants were consecutively enrolled from six United States PediatricMultiple Sclerosis Centers of Excellence. Participants had amean of 14.8 ± 2.6 years of age and an average disease duration of 1.9 ± 2.2 years. A total of 65 (35%) children with multiple sclerosis and 8 (18%) with clinically isolated syndrome met criteria for cognitive impairment. The most frequent areas involved were fine motor coordination (54%), visuomotor integration (50%), and speeded information processing (35%). A diagnosis of multiple sclerosis (odds ratio = 3.60, confidence interval = 1.07, 12.36, $P = .04$) and overall neurologic disability (odds ratio = 1.47, confidence interval = 1.10, 2.10, $P = .03$) were the only independent predictors of cognitive impairment. Cognitive impairment may occur early in these patients, and prompt recognition is critical for their care.

Cognitive Impairment



Cognitive Impairment

Areas of cognitive deficit can vary but often include

- Attention and speeded processing.
- Visuomotor functions.
- Memory.
- Receptive language and verbal fluency.

Cognitive Impairment

Table 4 Suggested core and supplemental neuropsychological battery

Domain	Test	Time, min	Age span, y	Core vs supplemental
Attention/IPS	SDMT (oral version)	5	8 and older	Core
	TMT-A	5	8–89	Core
Executive functioning	TMT-B	8	8–89	Core
	CNT	20	5–14	Supplemental
Verbal learning and memory	SRT	15	5–15	Core
Visual-spatial processing learning and memory	Beery VMI	5	2–100	Core
	BVMTR	10	6 and older	Supplemental
Language	D-KEFS fluencies (letter and category)	5	8–89	Core
	WASI vocabulary	10	6–89	Supplemental
General intelligence	WASI or	30	6–89	Supplemental
	WISC-IV	60	6–16	Supplemental

Abbreviations: BVMTR = Brief Visuospatial Memory Test-revised; CNT = Contingency Naming Test; D-KEFS = Delis-Kaplan Executive Function System; IPS = Integrated Processing Speed; SDMT = Symbol Digit Modalities Test; SRT = Selective Reminding Test; TMT = Trail-Making Test; VMI = Visual-Motor Integration; WASI = Wechsler Abbreviated Scale of Intelligence; WISC = Wechsler Intelligence Scale for Children.

Autoimmune Dis. 2013; 2013: 673947.

Diagnostic Categories to Exclude in Pediatric Multiple Sclerosis

Vascular/Inflammatory Disease

- CNS vasculitis/childhood primary CNS angiitis,
- Stroke,
- CADASIL,
- Autoimmune disease: systemic lupus erythematous, antiphospholipid antibody syndrome, neurosarcoidosis, Sjogren's syndrome,
- Migraine.

Metabolic/Nutritional

- Mitochondrial encephalopathy,
- Leukodystrophies,
- B12 or folate deficiency.

CNS Infection

- Neuroborreliosis,
- Herpes simplex encephalitis,
- Influenza ANE,
- Viral encephalitis.

Malignancy

- Lymphoma,
- Astrocytoma.

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MRI

In the prospective cohort study by Sadaka et al., the 2010 revised McDonald criteria:

- High Sensitivity (100%)
- Specificity (86%)
- Positive Predictive Value (76%)
- Negative Predictive Value (100%)

for children >12 years with non-ADEM presentations.

MRI

In younger children

- **These criteria are of less predictive value**
- **Not appropriate for application in the context of ADEM-like presentations.**

MRI

MRI in the diagnosis of pediatric multiple sclerosis.

Callen DJ[1], Shroff MM, Branson HM, Lotze T, Li DK, Stephens D, Banwell BL.

Results:

The presence of at least two of the following

- **five or more lesions**
- **two or more periventricular lesions.**
- **one brainstem lesion**

Can distinguished MS from other nondemyelinating disease controls with 85% sensitivity and 98% specificity.

MRI

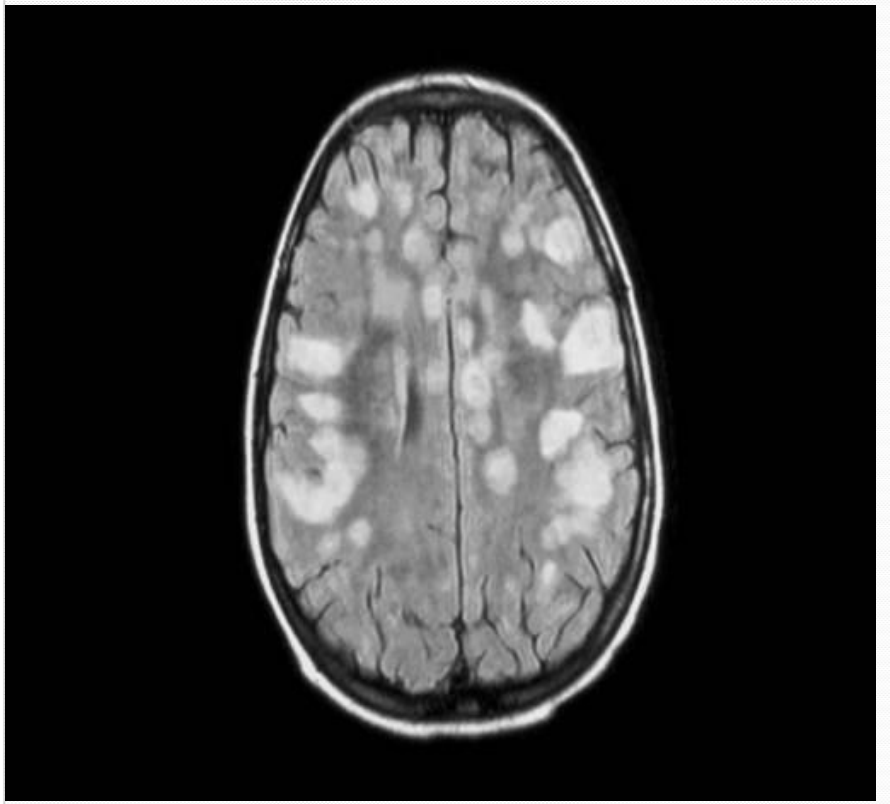
Most patients with ADEM show

(a) A diffuse bilateral pattern

(b) Absence of black holes

(c) Fewer than two PV lesions

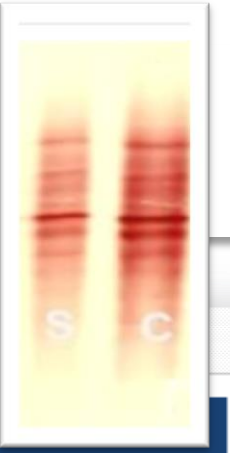
(sensitivity 81%, specificity 95%).



CSF

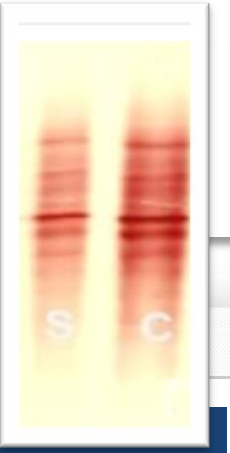
- Variable depending on the child's age.
- Age of the patient exerts a modifying effect on the CSF cellular profile.
- More neutrophils in the CSF

OCB



- In some cases, OCB initially can be negative and detected only later in the course of the disease.
- It has been reported that positive OCB may be found in 29% of patients with ADEM.

OCB



- Mikaeloff et al found that 94% of children with positive OCB went on to develop MS.
- Moreover, only 40% of patients with definitive diagnosis of MS had oligoclonal bands.
- These results suggest that OCB have low sensitivity but high specificity for the development of MS.

Visual Evaluation

Mult Scler. 2009 Jul;15(7):802-10. doi: 10.1177/1352458509104586. Epub 2009 May 22.

Retinal nerve fiber thickness in inflammatory demyelinating diseases of childhood onset.

Yeh EA[1], Weinstock-Guttman B, Lincoff N, Reynolds J, Weinstock A, Madurai N, Agarwal N, Buch P, Karpinski M, Ramanathan M.

- **Ocular coherence tomography (OCT) in children reported a significant retinal atrophy in the pediatric population with demyelinating disorders including optic neuritis, MS, and ADEM.**
- **Retinal atrophy was found to be more marked in patients with a previous episode of ON.**

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Treatment of an attack

- IV methyl prednisolone 20–30mg/kg (maximum 1g daily) for 3–5 days.
- Possible need for an oral taper.
- If there is an incomplete response or in case of a severe attack, intravenous immune globulin (IVIG) at 0.4g/kg/day for 5 days or plasmapheresis should be considered.

DMT

Neurology. 2006 Feb 28;66(4):472-6.

Safety and tolerability of interferon beta-1b in pediatric multiple sclerosis.

Banwell B[1], Reder AT, Krupp L, Tenembaum S, Eraksoy M, Alexey B, Pohl D, Freedman M, Schelensky L, Antonijevic I.

Author information

Abstract

BACKGROUND: Immunomodulatory therapies are widely used in adults with multiple sclerosis (MS) and safety and tolerability is well-established. Although at least 5% of all patients with MS experience the clinical onset of their disease prior to age 18 years, the available literature on safety and tolerability of immunomodulatory therapies for pediatric-onset MS is limited.

METHODS: The authors retrospectively reviewed safety and tolerability of interferon beta-1b (IFNbeta-1b) in a cohort of 43 children and adolescents treated for a mean of 29.2 months (SD 22.3 months).

RESULTS: Mean age at start of IFNbeta-1b treatment was 13 years. Eight children were < or =10 years. Most common adverse events included flu-like syndrome (35%), abnormal liver function test (26%), and injection site reaction (21%). No serious or unexpected adverse events were reported.

CONCLUSIONS: Although data on long-term effects on the maturing organ systems are lacking, the safety profile supports the safety and tolerability of interferon beta-1b (IFNbeta-1b) in children with multiple sclerosis and related diseases. All patients treated with IFNbeta-1b should undergo regular monitoring of liver function.

DMT

Neurotherapeutics. 2013 Jan;10(1):89-96. doi: 10.1007/s13311-012-0158-1.

Disease-modifying therapy of pediatric multiple sclerosis.

Chitnis T.

⊕ Author information

Abstract

Multiple sclerosis (MS) is increasingly recognized in children and adolescents. Improved awareness, access to care, and subspecialty training in pediatric MS has allowed for better access to treatment. Children with MS present with an overwhelmingly relapsing form of the disease and have more frequent relapses than their adult counterparts during the early phases of disease. Cognitive deficits are prominent in pediatric MS, as opposed to locomotor disability. Beta interferons and glatiramer acetate are frequently used off-label drugs. Additional second-line therapies have occasionally been used in treatment failures. No randomized clinical trials have been performed to date in pediatric MS; however, recent legislation necessitates pediatric studies for new agents, which will allow for better defined pharmacokinetic, dosing, and efficacy data to guide the treating neurologist.

DMT

First-line therapies include

1. Intramuscular interferon (IFN)-b1a (300mcg once a week)
2. Subcutaneous IFN b-1a (22 or 44mcg 3 times a week)
3. Subcutaneous ifn-b1 b (0.25mg every other day)
4. Glatiramer acetate (20mg/day) .

DMT

When to switch therapies?

1. Minimum time of full dose therapy of 6 months and

2. Full medication adherence and one of the following:

(a) increase or no reduction in the relapse rate or new T2 or enhancing lesion on MRI as compared to previous treatment **or**

(b) ≥2 confirmed MRI or clinical relapses within a 12-month period

DMT for refractory pediatric MS

Arch Neurol. 2008 Dec;65(12):1655-8. doi: 10.1001/archneur.65.12.1655.

Natalizumab use in pediatric multiple sclerosis.

Huppke P[1], Stark W, Zürcher C, Huppke B, Brück W, Gärtner J.

Conclusions

- **Natalizumab treatment was effective and well tolerated in our pediatric patients with RRMS who did not respond to initial immunomodulatory treatments.**
- **Therefore, it is a promising second-line therapy for pediatric patients with RRMS.**

DMT for refractory pediatric MS

Arch Neurol. 2012 Jan;69(1):78-81. doi: 10.1001/archneurol.2011.581.

Daclizumab use in patients with pediatric multiple sclerosis.

Gorman MP[1], Tillema JM, Ciliax AM, Guttmann CR, Chitnis T.

Results

- Reductions in annualized relapse rates and contrast-enhancing lesions.
- Reduction or stabilization of Expanded Disability Status Scale scores in each patient.

DMT for refractory pediatric MS

JAMA Neurol. 2013 Apr;70(4):469-75. doi: 10.1001/jamaneurol.2013.923.

Natalizumab therapy for highly active pediatric multiple sclerosis.

Kornek B[1], Aboul-Enein F, Rostasy K, Milos RI, Steiner I, Penzien J, Hellwig K, Pitarokoili K, Storm van's Gravesande K, Karenfort M, Blaschek A, Meyer A, Seidl R, Debelic D, Vass K, Prayer D, Kristoferitsch W, Bayas A.

Results

- Reductions in **mean annualized relapse rates** (3.7 without treatment vs 0.4 with treatment; P < .001), **median EDSS** (2 without treatment vs 1 with treatment; P < .02), and mean number of **new T2/FLAIR** lesions per year (7.8 without treatment vs 0.5 with treatment; P < .001).

DMT for refractory pediatric MS

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Natalizumab therapy for highly active pediatric multiple sclerosis.

Kornek B[1], Aboul-Enein F, Rostasy K, Milos RI, Steiner I, Penzien J, Hellwig K, Pitarokoili K, Storm van's Gravesande K, Karenfort M, Blaschek A, Meyer A, Seidl R, Debelic D, Vass K, Prayer D, Kristoferitsch W, Bayas A.

Results

- After the discontinuation of natalizumab therapy, relapse activity occurred in 6 of 8 patients within 6 months.

DMT for refractory pediatric MS

- Monoclonal antibody therapy (Natalizumab, daclizumab).
- Chemotherapeutic agents (Cyclophosphamide, mitoxantrone).
- Oral medications with novel mechanisms of action (Fingolimod, teriflunomide, and dimethyl fumarate).

Pediatric Multiple Sclerosis

Is it just an earlier onset ??

Pediatric Multiple Sclerosis

It is not just an earlier onset !


THANK YOU