DIAGNOSIS AUTISM: NOW WHAT? A SIMPLIFIED BIOMEDICAL APPROACH

By Dan Rossignol, MD, FAAFP

Dan Rossignol, MD, FAAFP received his Doctorate of Medicine at the Medical College of Virginia and completed his residency in family medicine at the University of Virginia (UVa). He is a former clinical assistant professor of family medicine at UVa and is currently a staff physician at the International Child Development Resource Center. He is the father of two children with autism. He has authored several papers including two on the use of HBOT in autism, one on the use of urinary porphyrins in autism, and another on mitochondrial dysfunction in autism. He is a medical advisor to the International Hyperbarics Association and USAAA, and is currently involved in research to find treatments for inflammation, oxidative stress, gastrointestinal problems and heavy metal toxicity in autism.

In 2002, my older son, Isaiah, was diagnosed with autism. At the time I had been practicing as a family physician for about five years. Prior to his diagnosis, Isaiah loved to get down on the floor and spin objects, and I thought it was cool, so I helped him. He also used to shake his hands back and forth in the air for hours. When I tried to shake my hands like him, I tired out in a couple of minutes. I couldn't figure out how he could do it for hours! He had a significant speech delay and walked very late. However, despite all of these problems, I did not have a CLUE that he had autism. I remember when my wife and I went to his psychological evaluation to determine what was wrong with him. He was evaluated by a pediatric neurologist and several psychologists, and we spent the morning with him during the testing. We were then told to go to lunch while the team met to determine a diagnosis. I remember as we sat in McDonalds eating French fries and cheeseburgers that my wife and I discussed that maybe the team would say he had "autistic tendencies." It was quite a shock to us when Isaiah was actually diagnosed with autism! For the first year after his diagnosis, my wife started looking into biomedical treatments, which I considered "quackery." I remember asking some pediatric neurologists about the gluten-free/casein-free (GF/CF) diet and being told that NO evidence existed in the medical literature as to whether or not this diet worked. When I finally realized that I needed to look into the medical literature for myself, I discovered some studies which reported that the GF/CF diet appeared to be beneficial in some children with autism[1,2]. Shortly after this, my second son, Joshua, was also diagnosed with autism. I now realize that God allowed us to have two children with autism to give me a new career (taking care of children with autism) and to give us the ability to help other parents who also have children with autism.

Now that I look back on things, I realize that we (me more so than my wife) wasted precious time because I didn't know what to do for my child. And I am a physician, and my wife is a nurse practitioner! Fortunately, there are currently many resources available to parents of a child with autism such as websites, books, and conferences. However, navigating through all of these possibilities can be daunting. The purpose of this article is to empower you, as a parent of a child with autism, by providing a starting point for biomedical treatments for your child.

Initially, the diagnosis of autism or other forms of autism, such as pervasive developmental disorder-not otherwise specified (PDD-NOS, also called high-functioning autism or mild autism), will generally come from a developmental pediatrician or a neurologist. Most neurologists will perform genetic testing (including chromosomal analysis and checking for fragile X syndrome), an MRI scan (to exclude some type of brain structural problem), and an EEG (to look for seizure activity). An EEG is especially important because newer studies are reporting that about 60% or more of children with autism have subclinical seizure activity (subclinical means that you are not aware of this seizure activity)[3,4]. We find significant improvements, especially in speech, in some children with autism when we treat seizures with medication.

After the initial diagnosis, there are specific laboratory tests that can be very helpful in either checking for other medical conditions (that could be exacerbating the autistic behavior) or defining underlying biomedical problems. Since autism is diagnosed based upon examination of the child's behavior, the actual diagnosis does not point to the underlying cause(s) of the disorder. We find that some of the core problems in autism include toxicity (including elevated levels of heavy metals, pesticides,

 REPRINTED WITH PERMISSION © THE AUTISM FILE

and other chemicals)[5,6], inflammation (potentially in the gastrointestinal tract and brain)[7-9], oxidative stress (damage to tissue caused by free radicals, which are neutralized by antioxidants such as vitamins C and E)[10], impaired glutathione production (which is the body's main natural detoxifier and antioxidant)[10], and impaired mitochondrial function (which are responsible for producing ATP, or energy)[11]. An in-depth discussion of each of these biomedical problems is beyond the scope of this article, but we will review simple laboratory tests and nutritional supplementation that any parent of a child with autism could start and which could potentially alleviate these problems and improve autistic behaviors.

Initial laboratory testing:

In many cases, a physician will need to order these tests for you.

The **Complete Blood Count (CBC) and Comprehensive Metabolic Panel** (CMP) check for anemia, platelet count (a high count is consistent with inflammation), and liver and kidney function.

Thyroid. We find a significant number of children with autism who have hypothyroidism, which can mimic some of the symptoms of autism and impair development. A simple blood test called TSH can check for this problem.

Iron deficiency can cause inattention and concentration problems[12]. Low iron is also linked to lowered IQ[13]. Iron supplementation in children with attention deficit hyperactivity disorder (ADHD) who have low iron levels has been shown to improve attention compared to a placebo [14], and iron supplementation in children with autism has been shown to improve sleep[15].

Ammonia and lactic acid are initial tests that can help determine if mitochondrial dysfunction exists, which can lead to low energy production and hypotonia (low muscle tone)[11] and is potentially treatable with supplements like coenzyme Q10 and L-carnitine.

Cholesterol. A cholesterol count less than 145 mg/dl in typical children has been shown to increase defiance and irritability and increase the chances of school suspension by three-fold[16]. Supplementation with cholesterol in some children with autism may be beneficial [17].

Cysteine is the precursor to glutathione and is the rate-limiting step for glutathione production. Low levels of cysteine reflect impaired glutathione production or increased glutathione utilization due to oxidative stress[18].

Lead has been shown in some studies to contribute to autistic behaviors in some children[19,20]. An elevated blood lead level reflects ongoing exposure and should prompt an investigation to find possible sources of lead in the house or environment.

Magnesium has a calming effect, and lower levels have been found in children with ADHD[21] and autism[22]. Magnesium supplementation can decrease hyperactivity[23] and improve certain autistic behaviors[22].

Testosterone. A small percentage of children with autism have elevated testosterone[24], which can lead to aggression.

The **organic acid panel (OAT)** is a specialized test that can measure markers of yeast, Clostridia, and other markers such as vitamin levels and mitochondrial function.

Urinary porphyrin concentrations can reflect increased heavy metal or pesticide levels in the kidney and are markers of the metal burden in the body[5].

Urinary neopterin is a marker of inflammation and tends to reflect autoimmunity in some children with autism[25]. Elevated neopterin often predicts positive responses to anti-inflammatory treatments.

Urinary oxidized DNA and RNA are markers of oxidative stress inside the cell[26], and children with elevated levels often have improvements with antioxidants.

Urinary isoprostane is a marker of oxidative stress outside the cell[26]. Again, antioxidants can be helpful when this is elevated.

Stool testing can check for the presence of inflammation, dysbiosis (increased levels of yeast and abnormal bacteria), digestion, and absorption.

Initial treatments:

There are certain treatments that parents can use to help improve certain behaviors in children with autism (and ADHD). The ideal treatment would be one that is well-studied, proven to be effective compared to a placebo, not too expensive, safe and tolerable, and can be done at home. Not many nutritional supplements fit into this category but several do. Many of these supplements are antioxidants that help to lower oxidative stress, which is a common finding in both ADHD[27] and autism[18]. With the use of an evidence-based medicine approach, parents can get started with some simple biomedical treatments based upon the above laboratory testing and/or the child's behaviors. For example, if oxidative stress is elevated, then antioxidants can be added. If a child has an attention problem, then supplements or dietary changes could be made that have been shown to improve attention.

Diet: Several studies have shown improvements in certain autistic behaviors, such as social isolation, communication, and overall behavior, with the use of a gluten-free/casein-free diet[1,2,28]. Food additives, colorings, and preservatives can increase hyperactivity in typical children [29], so avoiding these products can be helpful. In children with autism, testing for food allergies and eliminating reactive foods has been shown to improve certain autistic behaviors [30]. An organic diet can be helpful in eliminating pesticide exposures in children [31].

REPRINTED WITH PERMISSION © THE AUTISM FILE

A ketogenic diet can be helpful in some children with autism[32]. It should be noted that the use of specialized diets should be closely monitored by a physician or nutritionist.

Sleep: If this is a problem, I usually start with trying to improve sleep because autistic behaviors are usually worsened with sleep deprivation[33]. One recent study revealed a defect in the ASMT gene that resulted in less melatonin production in some children with autism (this defect was also found in some of the parents)[34]. Several studies have shown improvement in sleep with the use of melatonin in autism[35,36] and ADHD[37]. Melatonin at doses of 1-3 mg at bedtime is safe.

Multivitamin: A general moderate-dose multivitamin has been shown to improve sleep and gastrointestinal problems in children with autism when compared to a placebo[38].

Vitamin C: In a double-blind, placebo-controlled study, vitamin C (about 100 mg/kg) was shown to reduce stereotypical behavior (stimming) in individuals with autism compared to a placebo[39].

Methylcobalamin and folinic acid: Two studies have reported some improvements in certain autistic behaviors with the use of subcutaneous methylcobalamin injections (75 mcg/kg, requires a prescription) and oral supplementation of folinic acid (400 mcg twice a day)[10-40]. Methylcobalamin can also be given orally.

Zinc: Deficiency has been correlated with inattention in children with ADHD[41]. Zinc deficiency has also been reported in autism[42]. In one study of 400 children, the use of zinc sulfate (150 mg/day that provided 40 mg/day of elemental zinc) was shown to improve ADHD symptoms compared to a placebo[43].

Magnesium and vitamin B-6: The use of these (given together) has been shown to improve autistic behaviors, including social interaction, communication, and stereotypical behaviors[22], and improve hyperactivity in some children[44]. Typical doses are: magnesium at 6 mg/kg/day and vitamin B-6 at 0.6 mg/kg/day[22]; sometimes higher doses are used under physician supervision.

Pycnogenol: This has been shown to increase glutathione levels in children with ADHD[45], decrease oxidative stress[46], and improve attention, coordination, concentration, and hyperactivity compared to a placebo[47]. A typical dose is 1-2 mg/kg/day.

Carnitine: Deficiency has been described in some children with autism[48] and can impair mitochondrial function[11]. In one study of children with Rett syndrome, L-carnitine significantly improved sleep efficiency, energy level, and communication[49]. Carnitine has also been shown to improve attention and aggression in children with ADHD[50] as well as lessen hyperactivity[51]. Generally, we use 50-100 mg/kg/day of L-carnitine or Acetyl-L-carnitine (preferring the latter as it penetrates into the brain better).

Carnosine: This has strong antioxidant properties and also has been shown to decrease seizure activity. In one study, L-carnosine (400 mg twice a day) improved speech and social behavior compared to a placebo in children with autism[52].

Omega-3 fatty acids: Deficiency has been shown to increase hyperactivity, conduct problems, anxiety, and temper tantrums in typical children[53]. Infants not receiving omega-3 fatty acid supplementation in breast milk or infant formula are about 2-4 times more likely to develop autism[54]. Several studies have demonstrated improvements with the use of omega-3 fatty acids in children with developmental coordination disorder[55], ADHD[56], and autism[57,58]. Omega-3 fatty acids can also have anti-seizure effects [59]. I usually recommend about 800 mg of EPA and 800 mg of DHA (sometimes higher), which is the approximate dose used in a recent double-blind placebo-controlled study of children with autism showing improvements in hyperactivity and stereotypical behavior[58]. I also generally recommend starting antioxidants before omega-3 fatty acid supplementation.

Even though these treatments are available without a prescription, it is best to be under a physician's supervision when using these supplements and implementing significant dietary changes. Furthermore, a physician may be required to obtain certain laboratory tests and methylcobalamin injections. However, the supplements listed in this article are generally well-tolerated and can be helpful in improving certain behaviors in children with autism and ADHD. I would recommend sitting down with your child's physician to discuss these potential treatment options. May God bless you and your child as you journey together towards improvements and, I pray, eventual healing.

Table 1

Doses of antioxidants and other supplements (based on the studies reviewed):

Vitamin C: 100 mg/kg/day

Acetyl-L-carnitine: 50-100 mg/kg/day

L-carnosine: 200-400 mg twice a day

Pycnogenol: 1-2 mg/kg/day

Methylcobalamin injections: 75 mcg/kg 2-3 times per week

Folinic acid: 400 mcg twice a day

Omega-3 fatty acids: approx. 800 mg/day EPA and approx. 800 mg/day DHA

Zinc: 20-40 mg/day of elemental zinc

Melatonin: 1-3 mg, 30 minutes before bedtime

Magnesium: 6 mg/kg/day

Vitamin B-6: 0.6 mg/kg/day

REPRINTED WITH PERMISSION © THE AUTISM FILE

References

[1] Whiteley, P., et al., A gluten-free diet as an intervention for autism and associated spectrum disorders: preliminary findings. *Autism*, 1999. 3(1): p. 45.

[2] Knivsberg, A.M., et al., A randomised, controlled study of dietary intervention in autistic syndromes. *Nutr Neurosci*, 2002. 5(4): p. 251-61.

[3] Lewine, J.D., et al., Magnetoencephalographic patterns of epileptiform activity in children with regressive autism spectrum disorders. *Pediatrics*, 1999. 104(3 Pt 1): p. 405-18.

[4] Chez, M.G., et al., Frequency of epileptiform EEG abnormalities in a sequential screening of autistic patients with no known clinical epilepsy from 1996 to 2005. *Epilepsy Behav*, 2006. 8(1): p. 267-71.

[5] Nataf, R., et al., Porphyrinuria in childhood autistic disorder: implications for environmental toxicity. *Toxicol Appl Pharmacol*, 2006. 214(2): p. 99-108.

[6] Geier, D.A., et al., Biomarkers of environmental toxicity and susceptibility in autism. J Neurol Sci, 2009. 280(1-2): p. 101-8.

[7] Vargas, D.L., et al., Neuroglial activation and neuroinflammation in the brain of patients with autism. *Ann Neurol*, 2005. 57(1): p. 67-81.

[8] Li, X., et al., Elevated immune response in the brain of autistic patients. *J Neuroimmunol*, 2009.

[9] Torrente, F., et al., Small intestinal enteropathy with epithelial IgG and complement deposition in children with regressive autism. *Mol Psychiatry*, 2002. 7(4): p. 375-82, 334.

[10] James, S.J., et al., Metabolic biomarkers of increased oxidative stress and impaired methylation capacity in children with autism. *Am J Clin Nutr*, 2004. 80(6): p. 1611-7.

[11] Rossignol, D.A. and J.J. Bradstreet, Evidence of mitochondrial dysfunction in autism and implications for treatment. *American Journal of Biochemistry and Biotechnology*, 2008. 4(2): p. 208-217.

[12] Konofal, E., et al., Iron deficiency in children with attention-deficit/hyperactivity disorder. *Arch Pediatr Adolesc Med*, 2004. 158(12): p. 1113-5.

[13] Lozoff, B., et al., Long-lasting neural and behavioral effects of iron deficiency in infancy. *Nutr Rev*, 2006. 64(5 Pt 2): p. S34-43; discussion S72-91.

[14] Konofal, E., et al., Effects of iron supplementation on attention deficit hyperactivity disorder in children. *Pediatr Neurol*, 2008. 38(1): p. 20-6.

[15] Dosman, C.F., et al., Children with autism: effect of iron supplementation on sleep and ferritin. *Pediatr Neurol*, 2007. 36(3): p. 152-8.

[16] Zhang, J., et al., Association of serum cholesterol and history of school suspension among school-age children and adolescents in the United States. *Am J Epidemiol*, 2005. 161(7): p. 691-9.

[17] Aneja, A. and E. Tierney, Autism: the role of cholesterol in treatment. *Int Rev Psychiatry*, 2008. 20(2): p. 165-70.

[18] James, S.J., et al., Metabolic endophenotype and related genotypes are associated with oxidative stress in children with autism. *Am J Med Genet B Neuropsychiatr Genet*, 2006. 141(8): p. 947-56.

[19] Lidsky, T.I. and J.S. Schneider, Autism and autistic symptoms associated with childhood lead poisoning. *J Applied Research*, 2005. 5(1): p. 80-87.

[20] Accardo, P., et al., Autism and plumbism. A possible association. *Clin Pediatr (Phila)*, 1988. 27(1): p. 41-4.

[21] Kozielec, T. and B. Starobrat-Hermelin, Assessment of magnesium levels in children with attention deficit hyperactivity disorder (ADHD). *Magnes Res*, 1997. 10(2): p. 143-8.

[22] Mousain-Bosc, M., et al., Improvement of neurobehavioral disorders in children supplemented with magnesium-vitamin B6. II. Pervasive developmental disorder-autism. *Magnes Res*, 2006. 19(1): p. 53-62.

[23] Starobrat-Hermelin, B. and T. Kozielec, The effects of magnesium physiological supplementation on hyperactivity in children with attention deficit hyperactivity disorder (ADHD). Positive response to magnesium oral loading test. *Magnes Res*, 1997. 10(2): p. 149-56.

[24] Geier, D.A. and M.R. Geier, A clinical trial of combined anti-androgen and anti-heavy metal therapy in autistic disorders. *Neuro Endocrinol Lett*, 2006. 27(6): p. 833-8.

[25] Sweeten, T.L., D.J. Posey, and C.J. McDougle, High blood monocyte counts and neopterin levels in children with autistic disorder. *Am J Psychiatry*, 2003. 160(9): p. 1691-3.

[26] Ming, X., et al., Increased excretion of a lipid peroxidation biomarker in autism. *Prostaglandins Leukot Essent Fatty Acids*, 2005. 73(5): p. 379-84.

[27] Ross, B.M., et al., Increased levels of ethane, a non-invasive marker of n-3 fatty acid oxidation, in breath of children with attention deficit hyperactivity disorder. *Nutr Neurosci*, 2003. 6(5): p. 277-81.

[28] Millward, C., et al., Gluten- and casein-free diets for autistic spectrum disorder. *Cochrane Database Syst Rev*, 2008(2): p. CD003498.

[29] McCann, D., et al., Food additives and hyperactive behaviour in 3-year-old and 8/9-year-old children in the community: a randomised, double-blinded, placebo-controlled trial. *The Lancet*, 2007. 370(9598): p. 1560-7.

[30] Lucarelli, S., et al., Food allergy and infantile autism. *Panminerva Med*, 1995. 37(3): p. 137-41.

[31] Lu, C., et al., Organic diets significantly lower children's dietary exposure to organophosphorus pesticides. *Environ Health Perspect*, 2006. 114(2): p. 260-3.

[32] Evangeliou, A., et al., Application of a ketogenic diet in children with autistic behavior: pilot study. *J Child Neurol*, 2003. 18(2): p. 113-8.

[33] Schreck, K.A., J.A. Mulick, and A.F. Smith, Sleep problems as possible predictors of intensified symptoms of autism. *Res Dev Disabil*, 2004. 25(1): p. 57-66.

[34] Melke, J., et al., Abnormal melatonin synthesis in autism spectrum disorders. *Mol Psychiatry*, 2008. 13(1): p. 90-8.

[35] Andersen, I.M., et al., Melatonin for insomnia in children with autism spectrum disorders. *J Child Neurol*, 2008. 23(5): p. 482-5.

[36] Garstang, J. and M. Wallis, Randomized controlled trial of melatonin for children with autistic spectrum disorders and sleep problems. *Child Care Health Dev*, 2006. 32(5): p. 585-9.

[37] Van der Heijden, K.B., et al., Effect of melatonin on sleep, behavior, and cognition in ADHD and chronic sleep-onset insomnia. *J Am Acad Child Adolesc Psychiatry*, 2007. 46(2): p. 233-41.

[38] Adams, J.B. and C. Holloway, Pilot study of a moderate dose multivitamin/mineral supplement for children with autistic spectrum disorder. *J Altern Complement Med*, 2004. 10(6): p. 1033-9.

[39] Dolske, M.C., et al., A preliminary trial of ascorbic acid as supplemental therapy for autism. *Prog Neuropsychopharmacol Biol Psychiatry*, 1993. 17(5): p. 765-74.

[40] James, S.J., et al., Efficacy of methylcobalamin and folinic acid treatment on glutathione redox status in children with autism. *Am J Clin Nutr*, 2009. 89: p. 1-6.

[41] Arnold, L.E., et al., Serum zinc correlates with parent- and teacher- rated inattention in children with attention-deficit/hyperactivity disorder. *J Child Adolesc Psychopharmacol*, 2005. 15(4): p. 628-36.

[42] Yorbik, O., et al., Zinc status in autistic children. *J Trace Elem Exp Med*, 2004. 17(2): p. 101-107.

[43] Bilici, M., et al., Double-blind, placebo-controlled study of zinc sulfate in the treatment of attention deficit hyperactivity disorder. *Prog Neuropsychopharmacol Biol Psychiatry*, 2004. 28(1): p. 181-90.

[44] Mousain-Bosc, M., et al., Magnesium VitB6 intake reduces central nervous system hyperexcitability in children. *J Am Coll Nutr*, 2004. 23(5): p. 545S-548S.

[45] Dvorakova, M., et al., The effect of polyphenolic extract from pine bark, Pycnogenol on the level of glutathione in children suffering from attention deficit hyperactivity disorder (ADHD). *Redox Rep*, 2006. 11(4): p. 163-72.

[46] Chovanova, Z., et al., Effect of polyphenolic extract, Pycnogenol, on the level of 8-oxoguanine in children suffering from attention deficit/hyperactivity disorder. *Free Radic Res*, 2006. 40(9): p. 1003-10.

[47] Trebaticka, J., et al., Treatment of ADHD with French maritime pine bark extract, Pycnogenol. *Eur Child Adolesc Psychiatry*, 2006. 15(6): p. 329-35.

[48] Filipek, P.A., et al., Relative carnitine deficiency in autism. *J Autism Dev Disord*, 2004. 34(6): p. 615-23.

[49] Ellaway, C.J., et al., Medium-term open label trial of L-carnitine in Rett syndrome. *Brain Dev*, 2001. 23 Suppl 1: p. S85-9.

[50] Van Oudheusden, L.J. and H.R. Scholte, Efficacy of carnitine in the treatment of children with attention-deficit hyperactivity disorder. *Prostaglandins Leukot Essent Fatty Acids*, 2002. 67(1): p. 33-8.

[51] Torrioli, M.G., et al., A double-blind, parallel, multicenter comparison of L-acetylcarnitine with placebo on the attention deficit hyperactivity disorder in fragile X syndrome boys. *Am J Med Genet A*, 2008. 146(7): p. 803-12.

[52] Chez, M.G., et al., Double-blind, placebo-controlled study of L-carnosine supplementation in children with autistic spectrum disorders. *J Child Neurol*, 2002. 17(11): p. 833-7.

[53] Stevens, L.J., et al., Omega-3 fatty acids in boys with behavior, learning, and health problems. *Physiol Behav*, 1996. 59(4-5): p. 915-20.

[54] Schultz, S.T., et al., Breastfeeding, infant formula supplementation, and Autistic Disorder: the results of a parent survey. *Int Breastfeed J*, 2006. 1: p. 16.

[55] Richardson, A.J. and P. Montgomery, The Oxford-Durham study: a randomized, controlled trial of dietary supplementation with fatty acids in children with developmental coordination disorder. *Pediatrics*, 2005. 115(5): p. 1360-6.

[56] Sinn, N., J. Bryan, and C. Wilson, Cognitive effects of polyunsaturated fatty acids in children with attention deficit hyperactivity disorder symptoms: a randomised controlled trial. *Prostaglandins Leukot Essent Fatty Acids*, 2008. 78(4-5): p. 311-26.

[57] Meguid, N.A., et al., Role of polyunsaturated fatty acids in the management of Egyptian children with autism. *Clin Biochem*, 2008.

[58] Amminger, G.P., et al., Omega-3 fatty acids supplementation in children with autism: a double-blind randomized, placebo-controlled pilot study. *Biol Psychiatry*, 2007. 61(4): p. 551-3.

[59] Schlanger, S., M. Shinitzky, and D. Yam, Diet enriched with omega-3 fatty acids alleviates convulsion symptoms in epilepsy patients. *Epilepsia*, 2002. 43(1): p. 103-4.

REPRINTED WITH PERMISSION © THE AUTISM FILE