ELIZABETH STRICKLAND, MS,RD,LD

NUTRACEUTICALS AND AUTISM SPECTRUM DISORDER

NUTRACEUTICALS & ASD

• What are nutraceuticals?
• Nutraceuticals beneficial for ASD
  • Multi-vitamin/mineral
  • Vitamin C
  • Vitamin B12
  • Vitamin B6
  • Carnitine
  • Omega-3 fatty acids
  • Probiotics
  • Carnosine
Combating Autism Act

- Public Law 109-416
- Public Law 112-32
- Combating Autism Act established the Interagency Autism Coordinating Committee (IACC).

IACC is responsible for the development of a strategic plan for ASD research.
- The plan is updated yearly, identifying research gaps and proving direction for future research.
- From 2008 – 2012, $1.5 billion was expended by federal and private funding for ASD research.
Significant progress has been made regarding ASD in the past 5 years.

Due to ASD research there is greater understanding of the genetic & environmental factors contributing to ASD; also co-occurring conditions such as GI dysfunction.

Some of this new research investigates the role of nutraceuticals in treating ASD and supporting evidence shows its use to be very encouraging.

The term “Nutraceutical” is derived from the words “nutrition” and “pharmaceutical”.

• Coined in 1989 by the Foundation for Innovation in Medicine.
• Defined as a food, dietary supplement, or medical food that has medical or health benefits.
• The term “nutraceutical” has no meaning in U.S. law.
• Depending on the ingredients a product may be regulated as a drug, dietary supplement, food ingredient, or food.
The use of nutraceuticals in the treatment of ASD is becoming recognized as a promising approach.

- Multi-V/M
- Vitamin C
- Vitamin B12
- Vitamin B6
- Carnitine
- Omega-3 fatty acids
- Probiotics
- Carnosine

**MULTI-VITAMIN/MINERAL SUPPLEMENT**

MULTI-VITAMIN/MINERAL SUPPLEMENT

- Reduction in autism symptoms & metabolic indicators.
- Improvement in several nutritional biomarkers; biotin & vitamin K being the most significant.
- Significant improvements in biomarkers for metabolic status: sulfate, SAM, reduced glutathione, nitrotyrosine, ATP, NADH & NADPH.

MULTI-VITAMIN/MINERAL SUPPLEMENT

Research data supports the benefits of children with ASD taking a multi-vitamin and mineral supplement.

Registered Dietitian should advise parents on selecting an appropriate multi-vitamin and mineral supplement for their child.
VITAMIN C

SYNTHESIS
- Lipids
- Proteins
- Carnitine
- Tryptophan
- Thyroxin
- Norepinephrine
- Dopamine

COFACTOR
- CHO metabolism
- Folic acid → folinic acid
- Iron metabolism
- Oxidation-reduction
- Cholesterol → bile acid
- Cellular respiration

VITAMIN C

REDUCES
- Lipid peroxidation
- Oxidative DNA damage

Benefits of Vitamin C are attributed to antioxidant and free radical scavenging effects in oxidation-reduction reactions protecting against conditions associated with oxidative damage.
VITAMIN C

Placebo controlled trial; major findings indicated that the group given the vitamin C showed a reduction of autism symptoms and improvements in sensory motor scores.

A preliminary trial of ascorbic acid as a supplemental therapy for autism. Progress in neuropsychopharmacology. Biol Psychiatry 1993;17:765-774

VITAMIN C

Vitamin C dosage:
8g/70kg/day for 10 weeks

Parents should consult with a Registered Dietitian.
VITAMIN B12

Water-soluble B complex vitamin.

**Sources:**
- Meats
- Liver
- Poultry
- Fish
- Also produced by GI flora in the colon.

**Coenzyme form naturally found in food:**
- Adenosylcobalamin
- Methylcobalamin (methyl B12)

**Synthetic forms used in supplements:**
- Cyanocobalamin
- Hydroxocobalamin

Absorption of vitamin B12 requires:
- Intrinsic factor
- Normal gastric pH

Deficiency of vitamin B12 associated with:
- Inadequate dietary intake
- Malabsorption from food
- Gastritis
- Use of acid-suppressing drugs
A deficiency of vitamin B12 may result in neurologic damage beginning with an inability to produce myelin and progressing to degeneration of the axon and nerve head.

**Neurologic symptoms:**
- Depression
- Memory loss
- Personality changes
- Mood changes
- Ataxia
- Paresthesias
- Impaired cognitive performance

*Natural Medicines Comprehensive Database. www.naturaldata.com Sept 2014*

Vitamin B12 is required for:
- Methylation
- Myelin synthesis
- Cell reproduction
- Erythropoiesis
- Folate utilization
VITAMIN B12

The coenzyme form of vitamin B12 (methyl B12) has gained a lot of attention in the autism community.

Vitamin B12 (methyl B12) dependent pathways:
• Glutathione metabolism
• Transmethylation cycle
• Transsulfuration pathway

VITAMIN B12

Functions of methyl B12 dependent pathways are essential for error-free methylation & detoxification.

• DNA
• RNA
• Protein
• Phospholipids
• Neurotransmitters

• Increase levels of glutathione
GLUTATHIONE

Functions:

1. Antioxidant – protects all cells including brain cells against oxidative stress.
2. Detoxifies heavy metals.

It is believed that some children with ASD have reduced detoxification capacity and under chronic oxidative stress.

VITAMIN B12

Oxidative stress-related biomarkers in autism: systematic review and meta-analyses

Free Radic Biol Med.
2012;52(10):2128-2141


J Altern Complement Med.
2010;16(5):555-560

Efficacy of methylcobalamin and folinic acid treatment on glutathione redox status in children with autism.

Am J Clin Nutr.
2009;89(1):425-430
VITAMIN B12

Research study indicted that children with ASD had decreased blood levels of:

- Glutathione
- Glutathione peroxidase
- Methionine
- Cysteine

**Increased levels of:**

- Oxidized glutathione (inactive)

*Oxidative stress-related biomarkers in autism: systematic review and meta-analyses*  

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VITAMIN B12

**Injectable methyl B12**

**Dosage:**  
64.5 mcg/kg
Every 3 days for 6 weeks.

**Study results:**

- Increased glutathione plasma levels.
- Increased glutathione redox ratio (active to inactive).

**Researchers concluded:**

Methyl B12 may alleviate symptoms of autism in a subgroup of children by reducing oxidative stress.

*Pilot study of the effect of methyl B12 treatment on behavioral and biomarker measures in children with autism.*  
J Altern Complement Med. 2010;16(5):555-560
VITAMIN B12

Injectable methyl B12

Dosage:
- Methyl B12: 75 mcg/kg Twice per week
- Folinic acid: 400 mcg/kg Twice per day

Study results:
- Increase in cysteine, cysteinylglycine & glutathione.
- Increased glutathione redox ratio.

Researchers concluded:
- It appears that a subgroup of children with ASD may have deficits in methylation and detoxification capacity; so methyl B12 & folinic acid may be a clinical benefit in some children with autism.

Prior to a trial-response of methylcobalamin (methyl B12) and or methyl B12 & folinic acid; parents should consult with a Registered Dietitian.
VITAMIN B 6

Vitamin B6 is a complex of 6 vitamers:
- Pyridoxal
- Pyridorol
- Pyridoxamine
- And their 5’ phosphate esters

VITAMIN B6

The functions of vitamin B6 are performed by the biologically active form:
- Pyridoxal Phosphate (PLP or P5P)
**VITAMIN B6**

**SYNTHESIS**
- Hemoglobin
- Histamine
- Serotonin
- Dopamine
- Epinephrine
- Norepinephrine
- GABA

**COFACTOR**
- Glutathione production
- Metabolism of amino acids, glucose & lipids
- Gene expression

**MAGNESIUM**

**SYNTHESIS**
- Protein
- DNA
- RNA
- Glutathione

**COFACTOR**
- > 300 enzyme systems that regulate diverse biochemical reactions in the body
- Energy production
- Muscle & nerve function
- Blood glucose control
VITAMIN B6

Meta analysis of 18 studies revealed that supplementation with high-dose vitamin B6 in combination with magnesium showed improvement in children with ASD.

Autism, an extreme challenge to integrative medicine. Part 2: medical management.


VITAMIN B6

- The dosages in the studies for vitamin B6 varied greatly ranging from 75 to 1,000mg per day and magnesium ranging from 100 to 500mg per day.

- Multiple studies have shown the vitamin B6 and magnesium combination is more effective than vitamin B6 alone.

- The use of high-dose vitamin B6 and magnesium remained controversial because many studies had methodological shortcomings.
Currently

- > 22 studies of vitamin B6 and magnesium for the treatment of ASD
- 11 double-blind, placebo-controlled studies
- 1 study reported no significant improvement between the treatment & placebo groups
- Other studies found that some children with ASD benefited with significant improvements in many areas of their ASD symptoms

RESEARCH

Studied the effect of vitamin B6 and magnesium treatment on both clinical symptoms and biological parameters.

Title: “Improvement of neurobehavioral disorders in children supplemented with magnesium-vitamin B6. II. Pervasive developmental disorder-autism.”

Magnesium Research
VITAMIN B6

<table>
<thead>
<tr>
<th>Improvement Clinical Symptoms</th>
<th>Improvement Biological Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Social interactions</td>
<td>• Increased levels of intraerythrocyte magnesium (Erc-Mg) levels</td>
</tr>
<tr>
<td>• Communication</td>
<td></td>
</tr>
<tr>
<td>• Stereotyped behavior</td>
<td></td>
</tr>
<tr>
<td>• Abnormal functioning</td>
<td>Magnesium Research 2006 Mar;19(1):53-62</td>
</tr>
</tbody>
</table>

- Children with ASD compared to controls exhibited lower levels of Erc-Mg.
- Vitamin B6/magnesium treatment significantly improved clinical symptoms and Erc-Mg.
- When the vitamin B6/magnesium treatment was stopped, the ASD symptoms reappeared with a decrease in Erc-Mg levels.
- Vitamin B6 and magnesium may have a therapeutic role in treating ASD.

**VITAMIN B6**

**Vitamin B6 dosage:**
0.6mg/kg/day

**Magnesium dosage:**
6mg/kg/day

Due to the concern of potential vitamin B6 toxicity; high-dose vitamin B6 treatments must be monitored by a Registered Dietitian and/or physician.

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**CARNITINE**

Carnitine is the generic term for the compounds:

- L-carnitine
- Acetyl-L-carnitine
- Propionyl-L-carnitine
CARNITINE

Naturally | Supplement/Medication
--- | ---
Red meats, fish, poultry, milk and dairy products (whey component) | L-carnitine can be purchased over-the-counter
Synthesized in the body from essential amino acids lysine & methionine | Taken in the prescription form “Carnitor”

CARNITINE

**Functions:**

1. **Energy production**
   Transports long-chain fatty acids into the mitochondria to produce ATP.

2. **Waste removal**
   Transports waste out of the cell to prevent waste accumulation.

If ATP isn’t made efficiently, cells lack the energy needed to perform their normal functions and toxic byproducts such as free radicals, lactic acid, and other metabolites buildup in the cells.
CARNITINE

Efficacy of carnitine in the treatment of children with attention-deficit hyperactivity disorder.

Relative carnitine deficiency in autism.
J Autism Dev Disord 2004;34:615-623

A prospective double-blind, randomized clinical trial of levocarnitine to treat autism spectrum disorders.

Unique acyl-carnitine profiles are potential biomarkers for acquired mitochondrial disease in autism spectrum disorder.

CARNITINE

Research Results:

• 50% of boys with ADHD had a positive response to L-carnitine supplements.
• Children with ASD had reduced levels of free & total serum carnitine.
• >17% of children with ASD had abnormal acyl-carnitine levels consistent with abnormalities in fatty acid metabolism.
• L-carnitine supplementation significantly improved hand muscle strength, speech, sociability, cognitive & behavior in children with ASD.
CARNITINE

**L-carnitine dosage:**
50 mg/kg twice daily for three months

Parents should consult with a Registered Dietitian and/or physician.

• Researchers indicate that L-carnitine supplementation may be beneficial in treating a subgroup of individuals with ASD especially those with underlying acquired mitochondrial dysfunction or secondary carnitine deficiency.

OMEGA-3 FATTY ACIDS

• Docosahexaenioc acid (DHA)
• Eicosapentaenoic acid (EPA)

Essential polyunsaturated fatty acids that are crucial for brain development.
OMEGA-3 FATTY ACIDS

Functions:
• Major structural component of the brain.
• Supports neurotransmission among brain cells to provide optimal cognitive functioning.
• Component of the retina of the eyes supporting visual acuity and vision processing.

OMEGA-3 FATTY ACIDS

Deficiency of omega-3 fatty acids are linked to:
• Dyslexia
• ADHD
• Dyspraxia
• Depression
• Anxiety
• Autism
OMEGA-3 FATTY ACIDS

Plasma fatty acid levels in autistic children.
Prostaglandins Leukot Essent Fatty Acids. 2001;65(1);1-7

Syndrome of allergy, apraxia and malabsorption: characterization of a neurodevelopmental phenotype that responds to omega 3 and vitamin E supplementation.

Biol Psychiatry. 2007;61:551-533

OMEGA-3 FATTY ACIDS

A pilot randomized controlled trial of omega-3 fatty acids for autism spectrum disorder.
Journal of Autism disorders. 2011;41:545-554

Effects of large doses of arachidonic acid added to docosahexaenoic acid on social impairment in individuals with autism spectrum disorders: a double-blind, placebo-controlled, randomized trial.
Research indicated improvements in:

- Speech
- Eye contact
- Coordination
- Behavior
- Sensory function
- Hyperactivity
- Stereotypical behavior
- Social withdrawal

OMEGA-3 FATTY ACIDS

Dosage:
DHA – 700mg
EPA – 800mg
Once per day.

DHA & EPA – 1,300mg
Twice daily.

Researchers indicate that it appears omega-3 fatty acids hold promise as an effective treatment for certain ASD symptoms; but agree that further research is needed.

Parents should consult with a Registered Dietitian.
**PROBIOTICS**

Live microorganisms that are similar to the beneficial “good bacteria” found in the gastrointestinal tract.

**Two groups of bacteria used for probiotics:**
1. Lactobacillus
2. Bifidobacterium

Within each group there are different species: L. acidophilus, L. plantarum, L. rhamnosus, B. infantis and B. lactis

**Beneficial effects:**
1. Restoration and maintenance of intestinal microflora
2. Enhances the integrity of the gut mucosa.

Natural Health Products Directorate of Canada recommends a minimum amount for beneficial effect: > 5 Billion CFU
PROBIOTICS

- Severe GI problems in children with ASD may be due to an imbalance of the gut microflora.
- Rebalancing the microflora may help to alleviate GI disorders common in children with ASD.

*Difference between the gut microflora of children with autism spectrum disorders and that of healthy children.*

J Med Microbiol
2005;54(10):987-991

PROBIOTICS

“Behavior problems in children with ASD may be the primary or sole symptoms of gastrointestinal disorders.”

*Evaluation, diagnosis, and treatment of gastrointestinal disorders in individuals with ASDs: a consensus report.*

Pediatrics.
2010;125(Suppl 1):S1-S18
PROBIOTICS

Research Results:
• L. plantarum significantly increased lab counts of lactobacilli & enterococci
• Reduced counts of Clostridium
• Improved stool consistency
• Significantly improved behavior scores

A double-blind, placebo-controlled, crossover-designed probiotic feeding study in children diagnosed with autistic spectrum disorders.


PROBIOTICS

Research supports that GI problems may exacerbate ASD symptoms and that nutritional interventions such as probiotics can not only help heal the gut but also improve behavioral symptoms in children with ASD.
CARNOSINE
A dipeptide of the amino acids alanine and histidine. The body manufactures carnosine from dietary proteins.

Carnosine is highly concentrated in the:
- Brain
- Nervous system
- Lens of eyes
- Skeletal muscle

CARNOSINE

Function:
Carnosine has antioxidant properties scavenging reactive oxygen free radicals before they can damage cells.
CARNOSINE

Double-blind, placebo controlled study of L-carnosine supplementation in children with autism spectrum disorders.

J Child Neurol. 2001;17(11):833-837

Children taking the L-carnosine versus the placebo showed statistically significant changes according to various rating scales.

CARNOSINE

Research indicated improvements in:

• Auditory processing
• Language skills
• Speech production
• Socialization
• Fine motor skills

Researchers stated the mechanism of action of L-carnosine may be that it enhances neurologic function in the entorhinal or temporal cortex of the brain.
CARNOSINE

L-carnosine dosage:
800 mg per day

Parents should consult with a Registered Dietitian.

BASE-LINE DATA
(Prior to Trial Response)

Name: __________________________ Date: ____________

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>DESCRIBE IN DETAIL CHILD’S SYMPTOMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication</td>
<td></td>
</tr>
<tr>
<td>(verbal, speech, echolalia,</td>
<td></td>
</tr>
<tr>
<td>conversation, eye contact)</td>
<td></td>
</tr>
<tr>
<td>Social Interaction</td>
<td></td>
</tr>
<tr>
<td>(interaction with others,</td>
<td></td>
</tr>
<tr>
<td>social play, friendships)</td>
<td></td>
</tr>
<tr>
<td>Behavior</td>
<td></td>
</tr>
<tr>
<td>(self-injury, aggression,</td>
<td></td>
</tr>
<tr>
<td>tantrums, resistant to</td>
<td></td>
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<tr>
<td>change)</td>
<td></td>
</tr>
<tr>
<td>Activities &amp; Interest</td>
<td></td>
</tr>
<tr>
<td>(stereotyped movements,</td>
<td></td>
</tr>
<tr>
<td>preoccupation with objects</td>
<td></td>
</tr>
<tr>
<td>and/or one interest)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
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</tbody>
</table>
### SYMPTOMS

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Describe in detail child's symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleep</td>
<td>(falls asleep, stays asleep)</td>
</tr>
<tr>
<td>Enuresis (bed wetting)</td>
<td></td>
</tr>
<tr>
<td>Hyperactivity</td>
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</tr>
<tr>
<td>Focus &amp; Attention</td>
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<tr>
<td>Skin</td>
<td>eczema, hives, rashes</td>
</tr>
<tr>
<td>Ears</td>
<td>ear infections</td>
</tr>
<tr>
<td>Eyes</td>
<td>dark circles, red, itchy, watery</td>
</tr>
<tr>
<td>Respiratory</td>
<td>asthma, bronchitis, stuffy/nasal nose</td>
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<tr>
<td>Bowels</td>
<td>constipation, loose stools, diarrhea, gas, bloating</td>
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<tr>
<td>Feeding</td>
<td>limited variety of foods, refuse new foods</td>
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<td>Other</td>
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### TRIAL RESPONSE

(Dietary Intervention: ________________________)

<table>
<thead>
<tr>
<th>Name:</th>
<th>Dates: ______ to ______</th>
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<tbody>
<tr>
<td>Symptom</td>
<td>Substantial Improvement</td>
</tr>
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<td>Communication</td>
<td>(verbal, speech, echolalia, conversation, eye contact)</td>
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<td>Social Interaction</td>
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<tr>
<td>Behavior</td>
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<tr>
<td>Activities &amp; Interest</td>
<td>(uncoordinated movements, preoccupation with objects and/or one interest)</td>
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<td>Other</td>
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### SUMMARY

Research studies investigating the role of nutraceuticals in treating ASD continue to emerge.

Supporting evidence shows the use of nutraceuticals to be very encouraging.

RD can assist parents in making decisions regarding the use of nutraceutical to treat their child with ASD.

<table>
<thead>
<tr>
<th>SYMPTOM</th>
<th>Substantial Improvement</th>
<th>Improvement</th>
<th>No Change</th>
<th>Worsening</th>
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Q & A

ANY QUESTIONS?

THANK YOU!!!

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Book: Eating for Autism