

An Educational Webinar about Autism and Mitochondrial Function

by Dr. Suzanne Goh

I'm a pediatric neurologist and researcher in the field of mitochondrial dysfunction and autism. I've served as Co-Director of the Columbia University Developmental Neuropsychiatry Clinic for Autism and as Associate Research Scientist and Assistant Professor of Clinical Neurology in the Department of Psychiatry at Columbia University Medical Center. For many years, I've been researching mitochondrial function in autism – using a variety of techniques, including brain imaging and genetic approaches. I've also been diagnosing and treating mitochondrial dysfunction in children with autism in my own clinical practice.

One of the biggest problems I've found in the field of autism is that certain highly effective treatment strategies developed at leading university medical centers have not been made more widely accessible. In particular, many practitioners are not aware that nutritional supplements to improve and sometimes reverse the symptoms of autism are being used by expert physicians at world-class institutions.

Johns Hopkins University has been a leader in this practice. Dr. Richard Kelley is the director of the Division of Metabolism in the Department of Pediatrics at Johns Hopkins. He has published this practice guideline to educate physicians in the use of vitamins and nutritional supplements in patients with autism who also have a condition called mitochondrial disease (or mitochondrial dysfunction).

Dr. Richard Kelley writes,

“Our clinical experience at Kennedy Krieger Institute over the last 15 years has shown that a deficiency of mitochondrial complex I is a common cause of regressive autism. While permanent developmental losses can be substantial, especially in the few individuals who suffer more than one episode of regression, **recovery can be almost complete** in some children when treatment is started early after the first episode of regression, and a partial **response to metabolic therapy remains possible indefinitely.**”

The key, in my view, is to determine which children can potentially benefit from this type of metabolic therapy, and then to do whatever is needed to get them the nutritional supplements that can help with their recovery.

Several years ago, one of my patients – an 8-year-old boy with mitochondrial dysfunction and autism – was having a very difficult time taking the dozens of different pills and liquids that were part of his mitochondrial cocktail. He was taking carnitine, Coenzyme Q10, vitamin C, vitamin E, and several B vitamins. His mother was frustrated and she asked if I could help her find a solution. At the time, I didn't think there was anything that I could do, but she wouldn't take no for an answer. So together, we formed the company MitoMedical, with the goal of developing mitochondrial supplements based on what we considered to be best practices at leading universities, and to put these into a form that all individuals could take easily – even those with high sensitivity to taste and texture.

What I'd like to take you through are some of the basics of mitochondrial metabolism – what are mitochondria and what do they do? Then show you some of the latest research linking mitochondrial dysfunction to autism. And, finally, look at what leading university medical centers use to manage mitochondrial dysfunction in children with autism.

What is mitochondrial metabolism?

Metabolism is a general term that is used a lot, but it has a very specific meaning – it is the process where the body takes in nutrients and converts them to energy. In children with a metabolic disorder, there is a disturbance in the body's ability to utilize nutrients and convert these into energy stores. The parts of the cell that are primarily responsible for creating energy – in the form of ATP - are the MITOCHONDRIA. A single cell can have hundreds or thousands of mitochondria.

The density of mitochondria varies from tissue to tissue in the body depending on its energy requirement. Neurons and muscle cells, for example, have high energy demands, and therefore, have a high density of mitochondria. When mitochondria don't function well, these tend to be the parts of the body that show signs of poor function.

When mitochondria aren't functioning well many different types of symptoms can appear.

- Developmental delay or regression
- Language impairment
- Social impairment
- Intellectual disability
- Neuropsychiatric symptoms (ADHD, anxiety, OCD, depression)
- Seizures
- Headache
- Hearing impairment
- Weakness
- Exercise intolerance
- Small stature
- Gastrointestinal symptoms
- Others

Children with mitochondrial dysfunction may have any combination of these. All of these symptoms are common in children with autism.

What is the latest research on mitochondrial dysfunction in autism spectrum disorders?

Research in mitochondrial dysfunction in autism has grown in recent years, and there are now many research studies linking mitochondrial dysfunction to autism. (Citations for all of the research studies mentioned here can be found at the end of the article or on our website at www.mitomedical.com or at www.pubmed.org).

In a groundbreaking study in the Journal of the American Medical Association, researchers at the University of California Davis found that the majority of children with autism between the ages of 2 and 5 had signs of mitochondrial dysfunction in blood tests

A study in the Journal of Neurochemistry found biochemical evidence of mitochondrial dysfunction directly in post-mortem brain tissue of children with autism.

A study published by researchers at Columbia University found evidence of mitochondrial dysfunction in post-mortem brain tissue of both adults and children with autism.

Several other research publications that have come out in the past 10 years – all showing evidence for mitochondrial dysfunction in autism.

In a meta-analysis, researchers compiled the results of 18 different studies and found that 78% of those with autism had blood tests indicating mitochondrial dysfunction.

In an excellent review paper published in 2012, researchers explain how mitochondrial dysfunction can connect the diverse medical symptoms associated with autism, including symptoms in many different organs, like the brain, muscle, and gastrointestinal tract.

The book - *The Autism Revolution* - was published by Dr. Martha Herbert who is a pediatric neurologist and professor at Harvard Medical School. It has been instrumental in bringing attention to mitochondrial dysfunction and other medical aspects of autism that can be treated. She explains that, “Problems with the mitochondria create problems for the whole body – in particular the brain, which uses huge amounts of energy.” She also explains how many different types of triggers can lead to mitochondrial dysfunction, including gene mutations, shortages of key vitamins and minerals in the diet, certain chemicals, heavy metals, and drugs, certain bacteria and viruses, and stress. Mitochondrial dysfunction, therefore, is a potential explanation for how different types of environmental insults might lead to the symptoms of autism.

A clinical trial published in 2011 found that children with autism who were treated with L-carnitine (a compound that is important in mitochondrial function) had improvement in the symptoms of autism as well as improvement in muscle strength and intelligence. There hasn't been a clinical trial yet of the full mitochondrial cocktail, but this is something that needs to be done. It's possible that the improvement would be even more dramatic when other vitamins and supplements are given in addition to L-carnitine.

What do leading university medical centers use to manage mitochondrial dysfunction in children with autism?

The Kennedy Krieger Institute at Johns Hopkins University is one of the leading centers for the treatment of autism. They have been using vitamins and supplements in children with autism for over 15 years. They have treated hundreds of children with autism and mitochondrial disease using a mitochondrial cocktail. Patients come from all over the country to get the specialized evaluation and treatment that they offer. In order to help other physicians provide the same care to their patients, the group at Johns Hopkins has written a practice parameter to guide physicians in how to treat patients at their own clinics. This full article is available through our website at www.mitomedical.com

They use a mitochondrial cocktail that includes L-carnitine, Coenzyme Q10, vitamin C, vitamin E, vitamin B5, and alpha lipoic acid. L-carnitine, CoQ10, and Vitamin B5 work to improve the function of the mitochondrial respiratory chain, which is the portion of the mitochondrial that generates ATP which provides energy for all of the body's functions. Vitamin C, Vitamin E, and also CoQ10 function as anti-oxidants. Anti-oxidants are molecules that help to protect cells and components of cells from damage that can occur through a chemical reaction called oxidation. These ingredients are dosed by weight – so the more a child weighs, the higher the dose that is needed of each of these.

One of the biggest challenges is to get a child to take so many different supplements in large amounts. The current options are either to go through a compounding pharmacy OR to buy the individual components over the counter. The problem with going through a compounding pharmacy is that they are unregulated and there have been recent cases of contamination of products created by compounding pharmacies. In addition, there is no verification of the dose or the source of the ingredients so one needs to be confident about the quality of the particular compounding pharmacy that is creating the cocktail. The compounded cocktail is not shelf stable. It requires refrigeration, and even in the refrigerator it begins to degrade, so that the dosage on Day 1 may not be the same as the dosage on Day 7 or Day 14. The compounded cocktail has a taste and appearance that children often won't tolerate.

The problem with traditional over-the-counter supplements is that the quality of the manufacturer and ingredients is often questionable. It is hard to find products in the precise dosage for children. The stability is usually untested. The high pill burden is difficult for children to take and difficult for parents to dose correctly.

MitoSpectra is a new mitochondrial cocktail that we created based on the formulation developed at Johns Hopkins University. Through a unique delivery system we've been able to concentrate the 5 key ingredients (L-carnitine, Coenzyme Q10, Vitamin C, Vitamin E, and Vitamin B5) into a mild-tasting powder that is easily masked in soft foods and liquids. It is shelf stable without refrigeration, and it's manufactured in the U.S. under NSF-certified GMP standards as set by the FDA (the highest quality standards for dietary supplements). The purpose of MitoSpectra is to achieve better compliance – and with better compliance, comes better efficacy.

We're often asked what changes you can expect to see after starting a mitochondrial cocktail. The effects of many of the components can be seen within a few days, but the full effect isn't seen for several months, so it should be taken for at least 3 months before assessing its efficacy. This is standard for most supplements and also for many medications is that maximum effect isn't seen immediately, but rather over several months. Common effects after several months have been reported as increased energy, attention, social interaction, language, muscle tone, and coordination. Side effects are rare – and much less common than for medications, but they might include hyperactivity or difficulty sleeping. These can be addressed by increasing the dose more gradually and by taking the evening dose earlier in the day. Extra caution needs to be taken in children with a history of seizures or a predisposition to seizures because L-carnitine may transiently increase the risk of seizures. This effect can be mitigated by starting at a very low dose and increasing very gradually. Other side effects are possible depending on the individual patient, and these should be discussed with a personal physician.

Like other mitochondrial cocktails, MitoSpectra is dosed by weight. So, for example, a child weighing 25 pounds would take one packet of powder per day – one packet has about 1 teaspoon of powder. But a child weighing 90 pounds would take 4 packets per day. The daily dosage should be divided into two or three doses and taken with food during the course of the day.

There are several questions that we are often asked by parents and physicians – so the next two slides will address these questions. First, are diagnostic tests for mitochondrial dysfunction needed before starting a mitochondrial cocktail? Academic medical centers have a range of different diagnostic protocols. These often involve numerous, repeated blood draws and other invasive procedures. These complicated testing protocols are often not feasible in community clinics and

laboratories. On top of that challenge, many of the tests (such as blood lactate and pyruvate) have low sensitivity and have to be done under specific physiological conditions (such as during fasting, during illness, and others).

Because of these challenges, physicians are increasingly choosing to give an empirical trial of therapy over 3 to 6 months while they monitor for objective signs of improvement, such as changes in muscle tone, motor control, coordination, and cognitive and behavioral symptoms. An especially useful type of objective feedback is from other professionals – such as speech therapists, occupational therapists, physical therapists, or teachers – who do not know that the child is on a mitochondrial cocktail, and therefore won't be biased in their feedback.

In the past an empirical trial was difficult to do because compliance with pills and liquids was poor. MitoSpectra makes an empirical trial easier, which means that more clinicians now have the capability to emulate what is done at academic centers, and to offer patients something that they would otherwise not be able to.

Other mitochondrial cocktails are used by different clinics, and they sometimes include creatine, a range of B vitamins, alpha lipoic acid, and other ingredients. Any of these can be added to MitoSpectra. The purpose of MitoSpectra is to serve as a backbone – one that has the essential components of a mitochondrial cocktail. So that it dramatically simplifies the regiment that a patient needs to take.

MitoSpectra does not require a doctor's prescription – all of the ingredients are approved by the FDA for use without a doctor's prescription.

We're often asked whether there are particular symptoms that make it more likely that a patient has mitochondrial dysfunction. Some of the symptoms that are considered "classic" for mitochondrial dysfunction – that make physicians think that mitochondrial dysfunction is more likely, are – developmental regression (which means a loss of developmental skills), especially in the setting of illness or other stress, such as following a vaccine or after surgical procedure. Symptoms in more than one organ system, for example the brain, as well as the gastrointestinal tract. Family members who have symptoms that suggest mitochondrial dysfunction, such as diabetes, cardiomyopathy, liver failure, and learning disabilities.

For more information on mitochondrial function and MitoSpectra, go to our website at www.mitomedical.com or call us at 855-MITO-123. We have a medical advisory team that provides support to families and professionals, so please don't hesitate to contact us if we can be of any assistance.