

Running Head: PREVENTING MERCURY NEUROTOXICITY

Preventing Mercury Toxicity is Key to Lowering

Incidence of Autism Spectrum Disorder

Beth Yim

Vancouver Island University

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Instructor: Diane Pollard, Ph. D

## Preventing Mercury Neurotoxicity in Infants is Key to Lowering Incidence of Autism Spectrum Disorder

According to recent prevalence statistics from the Center for Disease Control and Prevention, 1 in 150 births will result in a child with autism. It is the fastest growing developmental disability in the United States and in Britain has an annual potential cost of \$90 billion dollars (Jarbrink, & Knapp, 2001). With such dramatic statistics government health boards, medical authorities, parents and potential parents need to be aware of the environmental factors that increase a child's vulnerabilities to developing autism and the preventive measures possible for lowering that risk.

Autism is a neurodevelopmental disorder characterized by impairments in social interaction, abnormal body movement patterns, repetitive behaviors and sensory dysfunction (Geier, Kern, Garver, Adams, Audhya, Nataf, & Geier, 2009). Individuals with autism have restricted verbal and non-verbal communication as well as odd patterns of behavior and hyper-focus (Rose, Melnyk, Savenka, Hubanks, Jernigan, Cleves, & James, 2008). Diagnosing the disorder is based on behavior criteria only, as researchers have not identified a single biological marker for the disorder. Instead, it has been classified as a multifactorial disorder, influenced by genetic, epigenetic and environmental factors.

For parents a diagnosis of autism can generate mixed feelings; relief at having a name put to their child's unique behavior, trepidation for their child's future with a significant disabling disorder and questions concerning cause and treatment. Though medical authorities are unable to indicate a single factor they do

understand that early intervention improves developmental outcomes (Mash, 2008) even though prevention and avoidance of the disorder would be the preferred and ideal alternative.

Currently, treatment involves intensive and highly structured training with one on one interaction between peers, teachers and family members. This treatment, though promising, can be costly both emotionally and financially, as family members must maintain the program's protocols over extended periods of time. Medication may also be used but its effectiveness vs. risks is in question and must be continuously assessed. Each of these modalities of treatment has merit but is focused on dealing specifically with symptoms. The cost of dealing with a child with autism for parents, educators and medical professionals is enormous.

Over the past few years there has been rising controversy over the link between heavy metal toxicity, specifically mercury, and the rise in cases of autism. The Autism Research Society hosts a comprehensive database of articles citing mercury as one of the possible environmental factors causing this increase in cases.

Mercury, a toxic heavy metal leaches in to the environment from a variety of sources, coal-powered and coal combusting plants (Song, Cheng & Lu, 2009) silver mining activity (Camargo, 2002), zinc smelting (Feng, Li, & Qui, 2004) pesticides (Clarkson, 2001), "chemical production, chlor-alkali factories, cement manufacturing, industrial, municipal and medical waste incineration, [and] emissions from landfill sites" (Camargo, 2002). A recent study conducted by Song, Cheng and Lu of Ryerson University's Department of Chemistry and Biology (2009) found a longer lasting form of mercury, atmospheric gaseous elemental mercury

(GEM), in higher concentrations in urban areas and during the hotter summer months. This is a concern because GEM can stay in the atmosphere for longer periods of time and travel over longer distances and with summers getting longer and hotter exposure rates could be extended.

Mercury does not break down in the environment, instead it bio-accumulates and biomagnifies as it works its way up the food chain. As a consequence it has become one of the “most hazardous environmental pollutants...reaching levels of potential (lethal and sublethal) toxicity” (Camargo, 2002), especially in our aquatic ecosystems.

The brain is a prime target for mercury toxicity due to a low oxidation rate that allows it to enter the central nervous system (Aschner, Lorscheider, Cowan, Conklin, Vimy, & Lash, 1997). Once in the CNS it is converted to a form that binds to endogenous sulfhydryl (SH), of which glutathione, a potent intracellular antioxidant, is the most abundant (Klaasen, Braken, Dudley, Goering, Hazelton, & Hjelle, 1985). Once mercury is bound to the -SH group it has access to the brain through the CNS.

Chronic exposure to mercury can cause loss of memory, insomnia, irritability, depression and hand and tongue tremors (Aschner et al, 1997). Mercury also impairs proper detoxification by interfering with methylation-specific activation and folate dependent methylation. Methylation is a process that decreases the amount of a specific gene expressed, as an example by protecting against tumour cell proliferation. Impaired DNA methylation, dopamine stimulating methylation and normal growth factor control over methylation has been implicated in other developmental disorders like Rett syndrome, and ADHD, (Waly, Olteanu, Banerjee,

Choi, Mason, Parker, Sukumar, Shim, Sharma, Benzecry, Power-Charnitsky, & Deth, 2004). In addition, mercury can cause oxidative stress by depleting the body of its most potent antioxidant, glutathione (Rose, Melnyk, Savenka, Hubanks, Jernigan, Cleves, & James, 2008).

The pathophysiology of autism is not clear. Though a genetic susceptibility could be involved, one estimate suggests 10% of cases are associated with a genetic abnormality (Lathe, 2008), the expression of this genetic liability may be dependent on environmental activation factors like exposure to mercury (Geier, 2009). In children with autism decreases in plasma glutathione have been found (Rose, 2008). Without this important antioxidant, heavy metals such as mercury cannot be detoxified as effectively.

Two theories could be extrapolated from this. First, that children or fetuses, with the genetic susceptibility that lessens their ability to eliminate mercury, could develop problems if exposed to the heavy metal. Second, that those genetically predisposed for developing autism could have a later development of the detoxification genes (DeSoto, & Hitlan, 2007). Either way children with autism have been found to have statistically significant levels of mercury in their blood as compared to a control group (DeSoto, & Hitlan, 2007) and low levels of mercury in hair samples (Holmes, 2003) both of which are suggestive that these children are unable to eliminate this toxic heavy metal.

Many reports strongly implicate intracellular redox imbalance and oxidative stress as a major causative factor in the development of autism. When combined with the genetic vulnerability for reduced capacity to eliminate mercury you have a

toxic heavy metal being deposited in bones, fatty tissues and the developing brain that continues impacting the mental and physical health of the developing child.

With the increase in numbers of children developing autism and the prohibitive costs involved in their care the need for a comprehensive and preventive program for prospective parents is clear. The developing brain is highly sensitive to neurotoxins yet many of the safe levels are evaluated for adult exposure not infants or developing fetuses. With children being insulted by environmental toxins on a daily basis their ability to metabolize toxins via the methylation and glutathione synthesis pathway is essential. Not only do these pathways prevent damage to the brain but they also support immune cell function and intracellular defense that could lead to inflammation and oxidative stress, both of which have been implicated in diseases and disorders other than autism.

The risk to children from neurotoxins is real and needs to be met aggressively with preventive programs geared towards educating parents and potential parents in the dangers of environmental toxins like mercury. The government must implement a pre pregnancy program that will help potential parents create a suitable environment for a developing fetus. Even better they need to make offending industries responsible for ensuring better air and water quality as well as participating in these education programs. In addition specific biomarkers, like reduced levels of glutathione should be routinely checked in infants to determine susceptibility and possible treatment protocols (Geier, 2009).

Autism is a disorder that can devastate a family. It reduces quality of life not only for the child but also for all members of the family. To care for the needs of the

child serves not only that individual and family but also the society he will grow into and serve. We need to take action now to preserve the health and welfare of our future generations.

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