Heavy Metal Toxicity and ADHD

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Attention-Deficit/Hyperactivity Disorder (ADHD) affects 3-5% of the population and is characterized by persistent problems with inattention, hyperactivity, and impulsivity (American Psychiatric Association, 2000). The New Zealand Ministry of Health (2001) quotes a 1987 figure from the Dunedin Health and Development Study (Anderson et al., 1987) of 6.7% prevalence of children in Dunedin.

Cumulative evidence shows that the long-term prognosis for ADHD is poor, with higher rates of persistent psychiatric problems (Shekim et al., 1990), neurocognitive difficulties (Murphy et al., 2002), and academic struggles (Ratey et al., 1992). Many theoretical models have been put forward to explain the cause of ADHD (Barkley, 1997); however, it is largely recognized that it is a heterogeneous disorder with multiple causal factors.

About 50% of prison inmates meet the ADHD criteria (e.g., Rasmussen et. al., 2001; Rosler et al., 2004; Andrade, 2004; Walsh, 1996). Denno (1990) showed from her 22 year study of 1000 children that the best predictor of aggressive behaviour in school, juvenile delinquency, and eventual criminal violence was the degree of lead poisoning. Violence is a characteristic of conduct disorder and lead poisoning, but is not a characteristic of ADHD.

However there is a strong co-morbid relationship between ADHD and conduct disorder with Green (1999) calculating that a third of ADHD clinical patients also have conduct disorder. Hinshaw's (1987) comprehensive review of ADHD and Conduct Disorder showed that children classified as hyperactive and aggressive overlap considerably. That is, 30%-90% of children in one group could also be classified in the other group using either cutoff scores or cluster analytic methods.

Ward’s study (2002) showed that on average the 1238 ADHD children compared to the 436 control children in his study had 2.5 times for level of lead, 3.8 times the level of aluminium, and six times the level of cadmium. In a separate study by Ward (1996) of 28 violent criminals, the pattern of heavy metal toxicity and mineral deficiencies were the same as for the ADHD group, but at a more extreme level.

The World Health Organization (WHO) has acknowledged environmental pollution as the underlying cause of 80% of all chronic degenerative diseases (Prüss-Üstün & Corvalán, 2006).

Considerable research links ADHD with high heavy metal levels, especially lead, aluminium, cadmium, mercury, manganese and copper (Ward, 2002; Eppright et al., 1996; Bellinger, 1994; David, 1974; Bock, 2007; Froehlich et al., 2006; Minder et al., 1994; Barlow 1983, Braun et al., 2006; Swartz et al., 2000; Tuthill, 1996; Needleman et al., 1979, 1982, 1990; 1993, 1996; Kostas, 1996; Stretesky, 2006; Wasserman, 2003; Mendelsohn, 1998). , a UK study (Lewendon, 2001) found ADHD students were 17 times more likely to have high lead levels than controls. But not all research shows a link (e.g., Kahn, Kelly, & Walker, 1995).

However, most of these studies used traditional urine, faeces, hair and blood tests. These are useful for showing recent exposure to environmental toxins but are less effective at showing if a body is failing to *eliminate* heavy metals. By contrast, the porphyrin urine tests measures evidence of heavy metal levels stored in the body, however this test has only recently become available in New Zealand.

We have been testing children with ADHD for heavy metals using hair tests. The results have been startling. These children are obtaining very high scores (between the 95th and 99.9th percentiles; e.g. the 99.9th percentile result was for 23mg/g with a reference range of less than 1.5mg/g) using Tissue Hair Mineral Analysis (THMA) for total heavy metal toxicity especially lead. For information on these tests see Watts (1995).

We have also been using been using the Ionic Heavy Metal Urine Test (IHMUT) since it became available in New Zealand in March 2006. This is a low cost and easy to administer test that has been useful for deciding if a more expensive test for heavy metals is required.

Unlike other systems developed for the detection of heavy metals (atomic absorption spectro photometry, electron stripping etc.) which detect total levels of heavy metals, the IHMUT detects only ionic and free radical producing metals. Electrically active heavy metal atoms that are not bound with organic complexes destroy molecular compounds causing the formation of free radicals. A healthy body can chelate free heavy metal atoms, i.e. neutralize their electromagnetic charge and clear them out. However, at higher levels of toxicity the number of free radicals will increase. The test detects heavy metals damaging the body, not metals being successfully bound and chelated from the body. We are finding that the test correlates well with other tests of heavy metal toxicity, but there is inadequate independent scientific research to confirm its effectiveness.

We have just started using porphyrin urine tests which only became commercially available in New Zealand in July 2007. However since this test is more expensive than other tests we are using IHMUT to get preliminary results.

The porphyrin shows the effect on the heme (hemoglobin) pathway of heavy metals in the tissues, so it is not necessary for the body to be eliminating the heavy metals to identify a heavy metal issue. When heme synthesis is disturbed, some porphyrin precursors to heme will build up inside the red blood cells, while other porphyrins are excreted in the urine and can be used as markers of genetic diseases or toxic exposures. The excess porphyrins in urine result from genetic deficiencies in several enzymes in the heme synthesis pathway(s), but can also be produced by inhibition of these same enzymes by toxins.

New research findings, such as by Kelsey (2005), are showing that some individuals have a gene that prevents the elimination of heavy metals.

About 80% of ADHD can be explained by genetic endowment (Sherman et al., 1997; Judziak et al., 2005; Kuntsi et al., 2005). However, studies linking ADHD with heavy metals indicate over 50% of hyperactive children have high levels of lead (e.g., Bock, 2007, David, 1974). The implication is that ADHD genes inhibit the elimination of heavy metals, or store them in the brain, or trigger expression of ADHD behaviours.

A few studies have looked at the impact of chelation on ADHD. However, these have significant issues such as needing to be administered every four hours, failure to chelate heavy metal from the brain, strip zinc and iron from the body causing brain damage, or lack the support systems to ensure that heavy metals that are chelated out of the cells are safely transported out of the body (Smith, 1998; Strupp, 2006).

Georgiou (2005) developed Heavy Metal Detox (HMD) from a large scale, three year Russian study. This natural product compound targets heavy metals rather than chelating all metals, and safely binds the heavy metals for elimination from the body. HMD is as effective as traditional systems, safer, and chelates from all parts of the body including the brain. HMD is available without prescription in many countries in the world including New Zealand.

We are offering a heavy metal detoxification programme to safely chelate heavy metals to patients with high toxicity levels. The process usually spans four months. The literature shows many practitioners are finding chelation to be very effective for reducing negative ADHD and conduct disorder behaviour. However we are not aware of any well constructed, double blind, placebo controlled chelation studies for people with ADHD, so no claims of effectiveness can be made.

There is relatively little research on ADHD and heavy metal toxicity but there is considerable research in other neurological conditions, most notably autism (eg Nataf et al., 2006; Geier & Geier, 2006).

References

Achenbach, T. (2001a). *Child Behaviour Checklist for ages 6-18*: Achenbach System of Empirically Based Assessment (ASEBA).

Achenbach, T. (2001b). *Teacher's Report Form for Ages 6-18.* (Achenbach System of Empirically Based Assessment (ASEBA).

Adams, W., & Sheslow, D. (2003). *Wide Range Assessment of Memory and Learning - Second Edition.* Wide Range Inc. USA.

American Psychiatric Association. (2000). *Diagnostic and statistical manual of mental disorders: DSM-IV-TR* (4th ed: Text revision ed.). Washington, DC: APA.

Anderson J. C., Williams S., McGee R. et al. (1987). DSM-III disorders in preadolescent children: prevalence in a large sample from the general population. *Archives of General Psychiatry, 44, 69–76.*

Andrade, R. C., Silva, V.A., & Assumpcao Jr. F. B. (2004). Preliminary data on the prevalence of psychiatric disorders in Brazilian male and female juvenile delinquents. *Brazilian Journal of Medical and Biological Research, 37,* 1155-1160.

Arnold, L. E. (1999). Treatment alternatives for attention-deficit/hyperactivity disorder (ADHD). *Journal of Attention Disorders, 3*(1), 30-48.

Asherson, P., Kuntsi, J., & Taylor, E. (2005). Unravelling the complexity of attention-deficit hyperactivity disorder: a behavioural genomic approach. *British Journal of Psychiatry, 187,* 103-5.

Barkley, R. A. (1997). Behavioral inhibition, sustained attention, and executive functions: Constructing a unifying theory of ADHD. *Psychological Bulletin, 121*, 65-94.

Barlow P. J. (1983). A Pilot Study on the Metal Levels in the Hair of Hyperactive Children *Med Hypotheses, 11(3),*309-18.

Beaudin, S., Stangle, D. E., Strawderman, M., Levitsky, D. A., & Strupp, B. J. (2007). Succimer chelation normalizes emotion regulation in rats exposed to lead early in life: Evidence from an olfactory conditional discrimination task with periodic omission of an expected reward. *Neurotox Teratol, 29,* 188–202.

Bellinger, D., Hu, H., Titlebaum, L., & Needleman, H. L. (1994). Attentional Correlates of Denin and Bone Lead Levels in Adolescents. *Archives of Environmental Health, 49,* 98-105.

Bock, K. (2007). *Healing the New Childhood Epidemics: Autism, ADHD, Asthma, and Allergies*, Ballantine Books.

Braun, J. M., Kahn, R. S., Froehlich, T., Auinger, P., & Lanphear, B. P. (2006). Exposures to Environmental Toxicants and Attention Deficit Hyperactivity Disorder in U.S. Children *Environmental Health Perspectives, 114,* 1904-1909.

Calderon, J., Navarro, M. E., Jimenez-Capdeville, M. E., Santos-Diaz, M. A., Golden, A., Rodriguez-Leyva, I., et al. (2001). Exposure to arsenic and lead and neuropsychological development in Mexican children. *Environmental Research, 8,* 69-76.

Comings, D. E., Chen, T. J. H., Blum, K., Mengucci, J. F., Blum, S. H., & Meshkin, B. (2005). Neurogenetic interactions and aberrant behavioral co-morbidity of attention deficit hyperactivity disorder (ADHD): dispelling myths. *Theor Biol Med Model, 2*, 50.

Costello, E. J., Mustillo, S., Erkanli, A., Keeler, G., Angold, A. (2003*).* Prevalence and development of psychiatric disorders in childhood and adolescence. *Archives of General Psychiatry, 60(8),* 837–844.

Dalteg, A., & Levander, S. (1998). Twelve thousand crimes by 75 boys: a 20-year follow-up study of childhood hyperactivity *Journal of Forensic Psychiatry, 9(1),* 39-57.

David, O. J. (1974). Association between Lower Level Lead Concentrations and Hyperactivity in Children*. Environmental Health Perspectives, 7,* 17–25.

de la Burde, B., & Choate, M. (1972). Does asymptomatic lead exposure in children have latent sequelae? *Journal of Pediatrics, 81,* 1088–1091.

de la Burde, B., & Choate, M. (1974). Early asymptomatic lead exposure and development at school age. *Journal of Pediatrics, 87,* 638–642.

D'Elia, L. F., Satz, P., Uchiyama, C. L., & White, T. (1996). *Colour Trails Test*: Psychological Assessment Resources.

Denno, D (1990). *Biology and Violence: From Birth to Adulthood*. Cambridge University Press

Dietrich K. N. et.al. (2004). Effect of Chelation Therapy on the Neuropsychological and Behavioral Development of Lead-Exposed Children After School Entry*. Pediatrics, 114(1),* 19-26.

Eppright, T. D., Sanfacon, J. A., & Horwitz, E. A. (1996). Attention deficit hyperactivity disorder, infantile autism, and elevated blood-lead: a possible relationship. *Missouri Medicine, 93(3),* 136-8.

Eyestone, L. L., & Howell, R. J. (1994). An epidemiological study of attention deficit hyperactivity disorder and major depression in a male prison population*, Bulletin of the American Academy of Psychiatry and Law, 22,*181-93.

Faraone, S. V., Spencer, T., Aleardi, M., Pagano, C., & Beiderman, J. (2004). Meta-Analysis of the Efficacy of Methylphenidate for Treating Adult Attention-Deficit/Hyperactivity Disorder. *Journal of Clinical Psychopharmacology, 24*(1), 24-29.

Fergusson, D. M., Fergusson, I. E., Horwood, L. J. & Kinzett, N. G. (1988). A longitudinal study of dentine lead levels, intelligence, school performance, and behaviour. *Journal of Child Psychology and Psychiatry, 29,* 811–824.

Fox, M. (2005) Unborn Babies Soaked in Chemicals, Survey Finds, *Reuters,* July 14.

Froehlich, T., Lanphear, B., Dietrich, K., Cory-Slechta, D., & Kahn, R. (2005). The Role of Dopamine Genotypes and Lead on ADHD-related Executive Function. *Journal of Developmental & Behavioral Pediatrics*, *26,* 466.

Froehlich, T.E., Lanphear, B. P., Dietrich, K. N., Cory-Slechta, D. A., Wang, N., & Kahn, R. S. (2007). Interactive Effects of a DRD4 Polymorphism, Lead, and Sex on Executive Functions in Children. *Biological Psychiatry, 62,* 243-249.

Fulton, M., Thomson, G., Hunter, R., Raab, G., Laxen, D., & Hepburn, W. (1987). Influence of blood lead on the ability and attainment of children. *Edinburgh* Lancet*, i,* 1221-6.

Geier, M., & Geier, D. (2006). A prospective assessment of porphyrins in autistic disorders: a potential marker for heavy metal exposure. *Neurotoxic Research, 10(1),* 57-64.

Georgiou, G. J. (2005). The Discovery of a Unique Natural Heavy Metal Chelator *Explore!* Volume 14:4.

Georgiou, GJ. (2007) A Natural Heavy Metal Chelator is Born: Its Use in Paediatric Cases. *British Naturopathic Journal,* 24, 1.

Georgiou, G.J. (2007) Do Natural Chelators Work? *Explore!* 16, 6.

Golden, C. J. (1978). *Stroop Color and Word Test: A manual for Clinical and Experimental Uses.* Wood Dale, Illinois: Stoelting Company*.*

Green M, Wong M, Atkins D et al. (1999). Diagnosis of Attention-Deficit/ Hyperactivity Disorder.Technical Review no. 3. *AHCPR Publication no. 99–0050. Rockville, MD: Agency for Health Care Policy and Research.*

Haley, B. E. (2005). Mercury toxicity: Genetic susceptibility and synergistic effects. *Medical Veritas, 2,* 535–542.

Hartmann T. (1999) *Attention Deficit Disorder – A Different Perception* Newleaf, Dublin, 189pp

Hinshaw, S. P. (1987) On the distinction between attentional deficits/hyperactivity and conduct problems/aggression in child psychopathology. *Psychological Bulletin, 101*, 443-463.

Hudziak, J. J., Derks, E. M., Althoff, R. R., Rettew, D. C., & Boomsma, D. I. (2005). The genetic and environmental contributions to attention deficit hyperactivity disorder as measured by the conners' rating scales – revised. *American Journal of Psychiatry, 162,* 1614–1620.

Kahn, C. A., Kelly, P. C., & Walker, W. O. Jr. (1995). Lead screening in children with ADHD and developmental delay. *Clinical Pediatrics, 34,* 498-501.

Keogh, J. P., Steffen, B., & Siegers, C-P. (1994). Cytotoxicity of heavy metals in the human small intestinal epithelial cell line 1-407: the role of glutathione. *Journal of Toxicology and Environmental Health, 43,* 351-359.

Klinghardt, D. A. (2007). Comprehensive Review of Heavy Metal Detoxification and Clinical Pearls from 30 Years of Medical Practice, *retrieved from:* www.sustainablehealth.org.uk.

Kollerstrom, H. (2006). Violent Crime, Hyperactivity & Metal Imbalance Review *The Nutrition Practitioner 7 Summer.*

Kostas, J., McFarland, D. J., & Drew, W. G.(1976). Lead-inducing hyperactivity. Chronic exposure during the neonatal period in the rat. *Pharmacology, 14(5),* 435-42.

Kuntsi, J., Rijsdijk, F., Ronald, A., Asherson, P., & Plomin, R. (2005). Genetic influences on the stability of attention-deficit/hyperactivity disorder symptoms from early to middle childhood. *Biological Psychiatry, 57,* 647–654.

Lathe, R. (2006). *Autism, Brain and Environment*, London: Jessica Kingsley.

Lewendon, G,Kinra, S., Nelder, R., & Cronin, T. (2001). Should children with developmental and behavioural problems be routinely screened for lead? *Arch Dis Child 85*(4), 286-8.

Liu, X., Dietrich, K. N., Radcliffe, J., Ragan, N. B., Rhoads, G. G., & Rogan, W. J. (2002) Do children with falling blood lead levels have improved cognition? *Pediatrics, 110(4),* 787-91.

Mannuzza, S., Klein, R.G., Bessler, A., Malloy, P, & LaPadula, M. (1993) Adult outcome of hyperactive boys: Education achievement, occupational rank, and psychiatric status. *Archives of General Psychiatry, 49,* 565-576

Maughan, B., Taylor, A., Caspi, A., *et al* (2004). Prenatal smoking and early childhood conduct problems: testing genetic and environmental explanations of the association. *Archives of General Psychiatry, 61,* 836 -843.

Mendelsohn, A. L., Dreyer, B. P., Fierman, A. H., Rosen, C. M., Legano, L. A., & Kruger, H. A. (1998). Low-level lead exposure and behavior in early childhood. *Pediatrics, 101 (3),* E10.

Murphy, P. (2002) Cognitive functioning in adults with Attention-Deficit/Hyperactivity Disorder. *Journal of Attention Disorders, 5(4),* 203-210.

Nataf, R., Skorupka, C., Amet, L., & Lam, A. (2006). Porphyrinuria in childhood autistic disorder: Implications for environmental toxicity, *Toxicol. Appl. Pharmacol., 214,* 99-108.

Needleman, H. L. (1993). The Current Status of Childhood Low-Level Lead Toxicity. *Neurotoxicology, 14(2-3),* 161-6.

Needleman H.L. (1982) The Neurobehavioral Consequences of Low Lead Exposure in Childhood. *Neurobehav Toxicol Teratol, 4(6),* 729-32.

Needleman H.L. (1994) Childhood Lead Poisoning. *Curr Opin Neurol, 7(2),* 187-190.

Needleman H.L., Gunnoe C., Leviton A., Reed R., Peresie H., Maher C., & Barrett P. (1979). Deficits in Psychologic and Classroom Performance of Children with Elevated Dentine Lead Levels. *New England Journal of Medicine, 130,* 689-695.

Needleman, H. L., Riess, J. A., Tobin, M. J., Biesecker, G. E., & Greenhouse, J. B. (1996). Bone lead levels and delinquent behavior. *JAMA, 275 (5),* 363-9.

Needleman, H. L., Schell, A., Bellinger, D. C., Leviton, A., & Allred, E. N. (1990). The long term effects of exposure to low doses of lead in childhood, an 11-year follow-up report. *New England Journal of Medicine, 322 (2),* 83-8.

New Zealand Ministry of Health (2001). *New Zealand Guidelines or the Assessment and Treatment of Attention-Deficit/Hyperactivity Disorder.* Ministry of Health, Wellington New Zealand.

Mannuzza, S., Klein, R. G., Bessler, A., Malloy, P., & LaPadula, M. (1993) Adult outcome of hyperactive boys: Education achievement, occupational rank, and psychiatric status *Archives of General Psychiatry, 49,* 565-576.

Minder, B., Das-Smaal, E. A., Brand, E. F., & Orlebeke, J. F. (1994). Exposure to lead and specific attentional problems in schoolchildren. *Journal of Learning Disabilities, 27 (6),* 393-9.

Prüss-Üstün, A. & Corvalán, C. (2006). *Preventing disease through healthy environments Towards an estimate of the environmental burden of disease,* World Health Organisation Publications.

Raloff, J. (1995). Gene appears to alter lead's toxicity*. Science News,* 147.

Rasmussen, K, Almvik, R, & Levander, S (2001*)* Attention deficit hyperactivity disorder, reading disability, and personality disorders in a prison population. *Journal of the American Academy of Psychiatry and the Law, 29,* 186- 93.

Ratey, J. J., Greenberg, M. S., Bemporad, J. R., & Lindem, K. J. (1992). Unrecognized attention-deficit/hyperactivity disorder in adults presenting for outpatient psychotherapy. *Journal of Child and Adolescent Psychopharmacology, 2,* 267-275.

Rogan, W. J. et. al. (2001). The effect of chelation therapy with succimer on neuropsychological development in children exposed to lead. *New England Journal of Medicine, 344 (10),* 1421-1426.

Rosler, M. et. al. (2004). Prevalence of attention deficit–/hyperactivity disorder (ADHD) and comorbid disorders in young male prison inmates. *European Archives of Psychiatry and Clinical Neuroscience, 254(6),* 365-371.

*Rucklidge, J. J., & Tannock, R. (2001). Psychiatric, psychosocial, and cognitive functioning of female adolescents with ADHD. *Journal of the American Academy of Child and Adolescent Psychiatry, 40*(5), 530-540.

Schwartz, B. S., Stewart, W. F., Kelsey, K. T., Simon, D., Park, S., Links, J. M., & Todd, A. C. (2000). Associations of tibial lead levels with BsmI polymorphisms in the vitamin D receptor in former organolead manufacturing workers. *Environmental Health Perspectives, 108.*

Shekim, W. O., Asarnow, R. F., Hess, E., Zaucha, K., & Wheeler, N. (1990). A clinical and demographic profile of a sample of adults with attention deficit hyperactivity disorder, residual state. *Comprehensive Psychiatry, 31*, 416-425.

Silva, P. A., Hughes, P.,Williams, S., & Faed, J. M. (1988). Blood lead, intelligence, reading attainment, and behaviour in eleven year old children in Dunedin, New Zealand*. Journal of Child Psychology and Psychiatry, 3,* 199-203.

Sherman, D. K., McGue, M. K., & Iacono, W. G. (1997). Twin concordance for attention deficit hyperactivity disorder: a comparison of teachers' and mothers' reports. *American Journal of Psychiatry, 154,* 532–535.

Smith, M. (2006*). Mental Retardation and Developmental Delay: Genetic and Epigenetic Factors.* Oxford, Oxford University Press.

Smith, D., Bayer, L., & Strupp, B. J. (1998). Efficacy of Succimer Chelation for Reducing Brain Pb Levels in a Rodent Model. *Environmental Research, 78(2),* 168-176.

Smith, C. M., Wang, X., Hu, H. & Kelsey, K. T. (1995). A polymorphism in the delta-aminolevulinic acid dehydratase gene may modify the pharmacokinetics and toxicity of lead. *Environmental Health Perspectives, 103 (3),* 248-53.

Stangle, D. E., Strawderman, M., Smith, D., Kuypers, M., & Strupp, B. J. (2004). Repeated regimens of Succimer show different treatment efficacy in brain versus blood in a rodent model of childhood lead exposure. *Environmental Health Perspectives, 112,* 302-308.

Stretesky, P. B., & Lynch, M.J. (2004). The Relationship between Lead and Crime. *Journal of Health and Social Behavior*, *45(2),* 214-229.

Tuthill, R. W. (1996). Hair lead levels related to children’s classroom attention-deficit behavior. *Archives of Environmental Health, 51 (3),* 214-20.

Walsh, W. (1996). Biochemical treatment of behavior disorders. *Proceeding of the Annual Meeting of the American Psychiatric Association, May 9*

Ward, N. (1996) Heavy Metal status of Incarcerated Young Offenders and Control Individuals *10th Conference on Heavy Metals in the Environment, Hamburg Symposium 1995, 277-280; CEP Consultants, Edinburgh*

Ward, N. (2002*)* The potential role of trace elements in child hyperkinetic disorders’, in: *Food Allergy and Intolerance*, (2nd Ed.) Ed. J.Brostoff and S.Challacombe, Saunders 2002, Ch. 52*.*

Wasserman, G. A., Factor-Litvak, P., Liu, X., Todd, A. C., Kline, J. K., Slavkovich, V., Popovac, D., & Graziano, J. H. (2003). The relationship between blood lead, bone lead and child intelligence*. Child Neuropsychology, 9(1),* 22-34.

Watts, D (1995) *Trace Elements & Other Essential Nutrients: Clinical Application of Tissue Mineral Anlaysis* Meltdown International

Wechsler, D. (2003). *Wechsler Intelligence Scale for Children - Fourth Edition.* The Psychological Corporation. USA.

Wechsler, D. (2002). *Wechsler Individual Achievement Test - Second Edition*. The Psychological Corporation. USA.

Wilson, M. A., Johnston, M. V., Goldstein, G. W., & Blue, M. E. (2000). Neonatal lead exposure impairs development of rodent barrel field cortex. *PNAS, 97(10),* 5540-5545.