

Manganese Health Research Program: Recent published literature

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Introduction

This report constitutes that fourth quarterly update for the current year, and includes papers identified as being first published between **December 2006** and **February 2007**. Bibliographic details are presented of recent literature addressing a number of research areas that are considered of direct relevance to the health effects of Manganese (Mn), and include:

Section 1 - EXPOSURE MEASUREMENT AND MODELLING: Papers relating to the measurements or modelling of environmental and occupational Mn exposure, the development of biomarkers of exposure or effect.

Section 2 - HEALTH EFFECTS: Papers on the influence of Mn on health, disease and dysfunction.

Section 3 - MECHANISMS: Papers on the physiological, biochemical and cellular mechanisms underlying the toxic effects of Mn.

Section 4 - HUMAN SUSCEPTIBILITY: Papers relating to assessment of the influence of genetic and epigenetic factors on human susceptibility to the effects of Mn.

Section 5 - TREATMENT AND IMAGING: Papers on the development and implementation of new medical approaches to the treatment of excessive Mn exposure.

Section 6 - MISCELLANEOUS: Other papers considered of interest or potential relevance to the study of the health effects of Mn.

The papers presented herein were identified using a series of structured searches of the following on-line databases: Medline, Toxline, Biological Sciences and Proquest Health. The paper abstracts were reviewed and categorised by an experience Scientist to confirm their relevance before inclusion in this report.

Future reports will present the literature published for the year 2007-2008 at 3-monthly (quarterly) intervals.

1. EXPOSURE MEASUREMENT AND MODELLING

Bouchard, M., Laforest, F. & Vandelac, L., *et al* (2007) Hair Manganese and Hyperactive Behaviors: Pilot Study of School-Age Children Exposed through Tap Water. *Environmental Health Perspectives*, 115(1), 122-127.

Ji, F., Luo, X.G. & Lu, L., *et al* (2006) Effect of manganese source on manganese absorption by the intestine of broilers. *Poultry Science*, 85(11), 1947-1952.

Jiang, Y., Zheng, W. & Long, L., *et al* (2007) Brain magnetic resonance imaging and manganese concentrations in red blood cells of smelting workers: Search for biomarkers of manganese exposure. *Neurotoxicology*, 28(1), 126-135.

Pinto, F.G., Rey, U.V. & Fernandes, E.F., *et al* (2006) Determination of Manganese in Urine and Whole Blood Samples by Electrothermal Atomic Absorption Spectrometry: Comparison of Chemical Modifiers. *Analytical Sciences*, 22(12), 1605-1610.

Röllin, H.B., Mathee, A. & Levin, J., *et al* (2007) Examining the association between blood manganese and lead levels in schoolchildren in four selected regions of South Africa. *Environmental Research*, 103(2), 160-167.

Thompson, K., Molina, R.M. & Donaghey, T., *et al* (2007) Olfactory uptake of manganese requires DMT1 and is enhanced by anemia. *The FASEB Journal*, 21(1), 223-230.

2. Health effects

Bouchard, M., Laforest, F. & Vandelac, L., *et al* (2007) Hair Manganese and Hyperactive Behaviors: Pilot Study of School-Age Children Exposed through Tap Water. *Environmental Health Perspectives*, 115(1), 122-127.

de Tollenaer, S.M., Buysse, C.M.P. & van den Anker, J.N., *et al* (2006) Life Threatening Central Nervous System Manifestations and Hypothermia due to Maneb Intoxication in a Child: A Case Report. *Therapeutic Drug Monitoring*, 28(6), 813.

Erikson, K.M., Thompson, K. & Aschner, J., *et al* (2007) Manganese neurotoxicity: A focus on the neonate. *Pharmacology & Therapeutics*, 113(2), 369-77.

Gonzalez-Reyes, R.E., Gutierrez-Alvarez, A.M. & Moreno, C.B. (2007) Manganese and epilepsy: A systematic review of the literature. *Brain Research Reviews*, 53(2), 332-336.

Greiffenstein, M. & Lees-Haley, P. (2007) Neuropsychological correlates of manganese exposure: A meta-analysis. *Journal of Clinical and Experimental Neuropsychology*, 29(2), 113-126.

Kenangil, G., Ertan, S. & Sayilir, I., *et al* (2006) Progressive motor syndrome in a welder with pallidal T1 hyperintensity on MRI: A two-year follow-up. *Movement Disorders*, 21(12), 2197-2200.

Xie, H-W., Li, D.Y. & Tang, G-H, *et al* (2006) Primary study on immune indices in manganese workers. *Chinese Journal of Industrial Medicine*, 19(5), 308-309.

3. Mechanisms

Anderson, J.G., Cooney, P.T. & Erikson, K.M. (2007) Brain manganese accumulation is inversely related to gamma-amino butyric acid uptake in male and female rats. *Toxicological Sciences*, 95(1), 188-195.

Anderson, J.G., Cooney, P.T. & Erikson, K.M. (2007) Inhibition of DAT function attenuates manganese accumulation in the globus pallidus. *Environmental Toxicology and Pharmacology*, 23(2), 179-184.

Aschner, M. & Dorman, D.C. (2006) Manganese : pharmacokinetics and molecular mechanisms of brain uptake. *Toxicological Reviews*, 25(3), 147-154.

Chaudhri, O.B., Parkinson, J.R.C. & Kuo, Y., *et al* (2006) Differential hypothalamic neuronal activation following peripheral injection of GLP-1 and oxyntomodulin in mice detected by manganese-enhanced magnetic resonance imaging. *Biochemical and Biophysical Research Communications*, 350(2), 298-306.

de Sousa, Paulo L., de Souza, Sandra L. & Silva, A.C., *et al* (2007) Manganese-enhanced magnetic resonance imaging (MEMRI) of rat brain after systemic administration of MnCl₂: Changes in T₁ relaxation times during postnatal development. *Journal of Magnetic Resonance Imaging*, 25(1), 32-38.

Domico, L.M., Zeevalk, G.D. & Bernard, L.P., *et al* (2006) Acute neurotoxic effects of mancozeb and maneb in mesencephalic neuronal cultures are associated with mitochondrial dysfunction. *Neurotoxicology*, 27(5), 816-25.

Erikson, K.M., Thompson, K. & Aschner, J., *et al* (2007) Manganese neurotoxicity: A focus on the neonate. *Pharmacology & Therapeutics*, 113(2), 369-77.

Garcia, S.J., Gellein, K. & Syversen, T., *et al* (2007) Iron deficient and manganese supplemented diets alter metals and transporters in the developing rat brain. *Toxicological Sciences*, 95(1), 205-214.

Guilarte, T.R., McGlothlan, J.L. & Degaonkar, M., *et al* (2006) Evidence for cortical dysfunction and widespread manganese accumulation in the nonhuman primate brain following chronic manganese exposure: a 1H-MRS and MRI study. *Toxicological Sciences*, 94(2), 351-358.

Hansen, S.L., Spears, J.W. & Lloyd, K.E., *et al* (2006) Feeding a low manganese diet to heifers during gestation impairs fetal growth and development. *Journal of Dairy Science*, 89(11), 4305-4311.

Hansen, S.L., Spears, J.W. & Lloyd, K.E., *et al* (2006) Growth, reproductive performance, and manganese status of heifers fed varying concentrations of manganese. *Journal of Animal Science*, 84(12), 3375-3380.

Hirata, Y., Meguro, T. & Kiuchi, K. (2006) Differential effect of nerve growth factor on dopaminergic neurotoxin-induced apoptosis. *Journal of Neurochemistry*, 99(2), 416-425.

Jadhav, S.H., Sarkar, S.N. & Aggarwal, M., *et al* (2007) Induction of oxidative stress in erythrocytes of male rats subchronically exposed to a mixture of eight metals found as

groundwater contaminants in different parts of India. *Archives of Environmental Contamination and Toxicology*, 52(1 (Print)), 145-151.

Lee, B., Hiney, J.K., Pine, M.D., Srivastava, V.K. & Dees, W.L. (2007) Manganese stimulates luteinizing hormone releasing hormone secretion in prepubertal female rats: hypothalamic site and mechanism of action. *The Journal of Physiology* [Online], 578(3), 765-772.

Liu, L., Xu, Z-F. & Jia, K. (2006) Effects of glutathione and alpha-lipoic acid on striatum neuron apoptosis induced by manganese in rats. *Chinese Journal of Public Health -Shenyang-*, 22(10), 1239-1241.

Liu, L., Xu, Z. & Yang, J-H. (2006) Experimental study of the effects of glutathione and alpha-lipoic acid on oxidative response induced by manganese in rats. *Chinese Journal of Industrial Medicine*, 19(2), 99-100.

Nakata, A., Araki, S. & Park, S., *et al* (2006) Decreases in CD8+ T, naive (CD4+CD45RA+) T, and B (CD19+) lymphocytes by exposure to manganese fume. *Industrial Health*, 44(4), 592-597.

Rovetta, F., Catalani, S. & Steimberg, N., *et al* (2007) Organ-specific manganese toxicity: a comparative in vitro study on five cellular models exposed to MnCl(2). *Toxicology in Vitro*, 21(2), 284-292.

Schneider, J.S., Decamp, E. & Koser, A.J., *et al* (2006) Effects of chronic manganese exposure on cognitive and motor functioning in non-human primates. *Brain Research*, 1118(1), 222-231.

Sestini, S., Notarantonio, L. & Cerboni, B., *et al* (2006) In vitro toxicity evaluation of silver soldering, electrical resistance, and laser welding of orthodontic wires. *European Journal of Orthodontics*, 28(6), 567.

Sistrunk, S.C., Ross, M.K. & Filipov, N.M. (2007) Direct effects of manganese compounds on dopamine and its metabolite Dopac: An *in vitro* study. *Environmental Toxicology and Pharmacology*, 23(3), 286-296.

Sung, J.H., Kim, C.Y. & Yang, S.O., *et al* (2007) Changes in blood manganese concentration and MRI T1 relaxation time during 180 days of stainless steel welding-fume exposure in cynomolgus monkeys. *Inhalation Toxicology*, 19(1), 47-55.

Tessier, D.M. & Pascal, L.E. (2006) Activation of MAP kinases by hexavalent chromium, manganese and nickel in human lung epithelial cells. *Toxicology Letters*, 167(2), 114-121.

Yokel, R.A. (2006) Blood-brain barrier flux of aluminum, manganese, iron and other metals suspected to contribute to metal-induced neurodegeneration. *Journal of Alzheimer's Disease*, 10(2-3), 223-253.

Zeng, J-P., Wang, L-X. & Xia, W., *et al* (2006) [Mechanism of reactive oxygen species in manganese chloride-induced apoptosis in PC12 cells]. *Zhonghua Lao Dong Wei Sheng Zhi Ye Bing Za Zhi = Zhonghua Laodong Weisheng Zhiyebing Zazhi = Chinese Journal of Industrial Hygiene and Occupational Diseases*, 24(3), 157-160.

Zhou, J-F., Li, S. & Long, S-J., *et al* (2006) Effect of barium and the joint action of uranium and manganese on mitochondrial lipid peroxidation of liver in rats. *Chinese Journal of Industrial Medicine*, 19(5), 305-306.

4. Human susceptibility

Ivanov, S.L., Iamshanov, V.A. & Kovan'ko, E.G., *et al* (2006) [Smoking affects metal-ecotoxicant accumulation and genotoxic reactions in leukocytes]. *Voprosy Onkologii*, 52(3), 326-335.

5. Treatment and imaging

Jiang, Y., Zheng, W. & Long, L., *et al* (2007) Brain magnetic resonance imaging and manganese concentrations in red blood cells of smelting workers: Search for biomarkers of manganese exposure. *Neurotoxicology*, 28(1), 126-135.

6. Miscellaneous

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Roth, J.A. (2006) Homeostatic and toxic mechanisms regulating manganese uptake, retention, and elimination. *Biological Research*, 39(1), 45-57.

Thomsen, H.S., Barentsz, J.O. & Burcharth, F., *et al* (2007) Initial clinical experience with oral manganese (CMC-001) for liver MR imaging. *European Radiology*, 17(1), 273-278.