

# **Manganese Health Research Program: Recent published literature**

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# Introduction

This report presents bibliographic details 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.

The papers presented were identified as being first published between **September 2006** and **November 2006**, together with some earlier papers not previously included in the on-line databases used to identify publications. Future reports will present the literature published during subsequent 3-monthly (quarterly) intervals.

# 1. EXPOSURE MEASUREMENT AND MODELLING

Boudia, N., Halley, R. & Kennedy, G., *et al* (2006) Manganese concentrations in the air of the Montreal (Canada) subway in relation to surface automobile traffic density. *The Science of the Total Environment*, 366(1), 143-147.

Ellingsen, D.G., Dubeikovskaya, L. & Dahl, K., *et al* (2006) Air exposure assessment and biological monitoring of manganese and other major welding fume components in welders. *Journal of Environmental Monitoring*, 10(8), 1078-1086.

Ohashi, F., Fukui, Y. & Takada, S., *et al* (2006) Reference values for cobalt, copper, manganese, and nickel in urine among women of the general population in Japan. *International Archives of Occupational and Environmental Health*, 80(2), 117-126.

Pejovic-Milic, A., Byun, S.H. & Chettle, D.R., *et al* (2006) Development of an irradiation/shielding cavity for in vivo neutron activation analysis of manganese in human bone. *Journal of Radioanalytical and Nuclear Chemistry*, V269(2), 417-420.

Taylor, M.D., Erikson, K.M. & Dobson, A.W., *et al* (2006) Effects of inhaled manganese on biomarkers of oxidative stress in the rat brain. *Neurotoxicology*, 27(5), 788-797.

Yokel, R.A., Lasley, S.M. & Dorman, D.C. (2006) The speciation of metals in mammals influences their toxicokinetics and toxicodynamics and therefore human health risk assessment(1). *Journal of Toxicology and Environmental Health. Part B, Critical Reviews*, 9(1), 63-85.

## 2. HEALTH EFFECTS

Ardizzone, G., Arrigo, A. & Schellino, M.M., *et al* (2006) Neurological complications of liver cirrhosis and orthotopic liver transplant. *Transplantation Proceedings*, 38(3), 789-792.

Dorman, D.C., Struve, M.F. & Clewell, H.J., 3rd, *et al* (2006) Application of pharmacokinetic data to the risk assessment of inhaled manganese. *Neurotoxicology*, 27(5), 752-764.

Gobba, F. (2006) Olfactory toxicity: long-term effects of occupational exposures. *International Archives of Occupational and Environmental Health*, 79(4), 322-331.

Klos, K.J., Chandler, M. & Kumar, N., *et al* (2006) Neuropsychological profiles of manganese neurotoxicity. *European Journal of Neurology*, 13(10), 1139-1141.

Park, J., Yoo, C. & Sim, C.S., *et al* (2006) A retrospective cohort study of Parkinson's disease in Korean shipbuilders. *Neurotoxicology*, 27(3), 445-449.

Ross, C., O'Reilly, D.S.J. & McKee, R. (2006) Potentially clinically toxic concentrations of whole blood manganese in a patient fed enterally with a high tea consumption. *Annals of Clinical Biochemistry*, 43(3), 226-228.

### 3. MECHANISMS

Bae, J., Jang, B. & Suh, S., *et al* (2006) Manganese induces inducible nitric oxide synthase (iNOS) expression via activation of both MAP kinase and PI3K/Akt pathways in BV2 microglial cells. *Neuroscience Letters*, 398(1-2), 151-154.

Bunderson, M., Pereira, F. & Schneider, M.C., *et al* (2006) Manganese enhances peroxynitrite and leukotriene E4 formation in bovine aortic endothelial cells exposed to arsenic. *Cardiovascular Toxicology*, 6(1), 15-23.

Chen, B., Wu, C. & Chang, J. (2006) An assessment of the toxicity of metals to *Pseudomonas aeruginosa* PU21 (Rip64). *Bioresource Technology*, 97(15), 1880-1886.

Chen, C., Ou, Y. & Lin, S., *et al* (2006) Manganese modulates pro-inflammatory gene expression in activated glia. *Neurochemistry International*, 49(1), 62-71.

Chen, M., Cheng, G. & Lin, C., *et al* (2006) Effects of acute manganese chloride exposure on lipid peroxidation and alteration of trace metals in rat brain. *Biological Trace Element Research*, 110(2), 163-178.

Dorman, D.C., Struve, M.F. & Wong, B.A., *et al* (2006) Correlation of brain magnetic resonance imaging changes with pallidal manganese concentrations in rhesus monkeys following subchronic manganese inhalation. *Toxicological Sciences : An Official Journal of the Society of Toxicology*, 92(1), 219-227.

Dukhande, V.V., Malthankar-Phatak, G.H. & Hugus, J.J., *et al* (2006) Manganese-Induced Neurotoxicity is Differentially Enhanced by Glutathione Depletion in Astrocytoma and Neuroblastoma Cells. *Neurochemical Research*, V31(11), 1349-1357.

Eybl, V., Kotyzová, D. & Lesetický, L., *et al* (2006) The influence of curcumin and manganese complex of curcumin on cadmium-induced oxidative damage and trace elements status in tissues of mice. *Journal of Applied Toxicology : JAT*, 26(3), 207-212.

Fitsanakis, V.A., Au, C. & Erikson, K.M., *et al* (2006) The effects of manganese on glutamate, dopamine and gamma-aminobutyric acid regulation. *Neurochemistry International*, 48(6-7), 426-433.

Garcia, S.J., Gellein, K. & Syversen, T., *et al* (2006) A manganese-enhanced diet alters brain metals and transporters in the developing rat. *Toxicological Sciences : An Official Journal of the Society of Toxicology*, 92(2), 516-525.

Guilarte, T.R., Chen, M.K. & McGlothan, J.L., *et al* (2006) Nigrostriatal dopamine system dysfunction and subtle motor deficits in manganese-exposed non-human primates. *Experimental Neurology*, 202(2), 381-390.

Gunter, K.K., Aschner, M. & Miller, L.M., *et al* (2006) Determining the oxidation states of manganese in NT2 cells and cultured astrocytes. *Neurobiology of Aging*, 27(12), 1816-1826.

Gunter, T.E., Gavin, C.E. & Aschner, M., *et al* (2006) Speciation of manganese in cells and mitochondria: a search for the proximal cause of manganese neurotoxicity. *Neurotoxicology*, 27(5), 765-776.

Halatek, T., Opalska, B. & Rydzynski, K., *et al* (2006) Pulmonary response to methylcyclopentadienyl manganese tricarbonyl treatment in rats: injury and repair evaluation. *Histology and Histopathology*, 21(11), 1181-1192.

Hazell, A.S., Normandin, L. & Norenberg, M.D., *et al* (2006) Alzheimer type II astrocytic changes following sub-acute exposure to manganese and its prevention by antioxidant treatment. *Neuroscience Letters*, 396(3), 167-171.

He, L., Girijashanker, K. & Dalton, T.P., *et al* (2006) ZIP8, member of the solute-carrier-39 (SLC39) metal-transporter family: characterization of transporter properties. *Molecular Pharmacology*, 70(1), 171-180.

Hussain, S.M., Javorina, A.K. & Schrand, A.M., *et al* (2006) The interaction of manganese nanoparticles with PC-12 cells induces dopamine depletion. *Toxicological Sciences : An Official Journal of the Society of Toxicology*, 92(2), 456-463.

Isaac, A.O., Kawikova, I. & Bothwell, A.L.M., *et al* (2006) Manganese Treatment Modulates the Expression of Peroxisome Proliferator-activated Receptors in Astrocytoma and Neuroblastoma Cells. *Neurochemical Research*, V31(11), 1305-1316.

Lee, B., Pine, M. & Johnson, L., *et al* (2006) Manganese acts centrally to activate reproductive hormone secretion and pubertal development in male rats. *Reproductive Toxicology*, 22(4), 580-585.

Li, G.J., Choi, B.S. & Wang, X., *et al* (2006) Molecular mechanism of distorted iron regulation in the blood-CSF barrier and regional blood-brain barrier following in vivo subchronic manganese exposure. *Neurotoxicology*, 27(5), 737-744.

Liu, X., Sullivan, K.A. & Madl, J.E., *et al* (2006) Manganese-induced neurotoxicity: the role of astroglial-derived nitric oxide in striatal interneuron degeneration. *Toxicological Sciences : An Official Journal of the Society of Toxicology*, 91(2), 521-531.

Poma, A., Limongi, T. & Pisani, C., *et al* (2006) Genotoxicity induced by fine urban air particulate matter in the macrophages cell line RAW 264.7. *Toxicology in Vitro*, 20(6), 1023-1029.

Puli, S., Lai, J.C. & Edgley, K.L., *et al* (2006) Signaling pathways mediating manganese-induced toxicity in human glioblastoma cells (u87). *Neurochemical Research*, 31(10), 1211-1218.

Reaney, S.H., Bench, G. & Smith, D.R. (2006) Brain accumulation and toxicity of Mn(II) and Mn(III) exposures. *Toxicological Sciences : An Official Journal of the Society of Toxicology*, 93(1), 114-124.

Reichel, C.M., Wacan, J.J. & Farley, C.M., *et al* (2006) Postnatal manganese exposure attenuates cocaine-induced locomotor activity and reduces dopamine transporters in adult male rats. *Neurotoxicology and Teratology*, 28(3), 323-332.

Sakurai, T., Ohta, T. & Tomita, N., *et al* (2006) Evaluation of immunotoxic and immunodisruptive effects of inorganic arsenite on human monocytes/macrophages. *International Immunopharmacology*, 6(2), 304-315.

Salehi, F., Normandin, L. & Krewski, D., *et al* (2006) Neuropathology, tremor and electromyogram in rats exposed to manganese phosphate/sulfate mixture. *Journal of Applied Toxicology : JAT*, 26(5), 419-426.

- Silva, R.F.M., Falcão, A.S. & Fernandes, A., *et al* (2006) Dissociated primary nerve cell cultures as models for assessment of neurotoxicity. *Toxicology Letters*, 163(1), 1-9.
- Sumanont, Y., Murakami, Y. & Tohda, M., *et al* (2006) Prevention of kainic acid-induced changes in nitric oxide level and neuronal cell damage in the rat hippocampus by manganese complexes of curcumin and diacetylcurcumin. *Life Sciences*, 78(16), 1884-1891.
- Tapin, D., Kennedy, G. & Lambert, J., *et al* (2006) Bioaccumulation and locomotor effects of manganese sulfate in Sprague-Dawley rats following subchronic (90 days) inhalation exposure. *Toxicology and Applied Pharmacology*, 211(2), 166-174.
- Taylor, M.D., Erikson, K.M. & Dobson, A.W., *et al* (2006) Effects of inhaled manganese on biomarkers of oxidative stress in the rat brain. *Neurotoxicology*, 27(5), 788-797.
- Tjalkens, R.B., Zoran, M.J. & Mohl, B., *et al* (2006) Manganese suppresses ATP-dependent intercellular calcium waves in astrocyte networks through alteration of mitochondrial and endoplasmic reticulum calcium dynamics. *Brain Research*, 1113(1), 210-219.
- Veranth, J.M., Moss, T.A. & Chow, J.C., *et al* (2006) Correlation of in vitro cytokine responses with the chemical composition of soil-derived particulate matter. *Environmental Health Perspectives*, 114(3), 341-349.
- Yang, H., Wang, T. & Li, J., *et al* (2006) Decreasing expression of alpha1C calcium L-type channel subunit mRNA in rat ventricular myocytes upon manganese exposure. *Journal of Biochemical and Molecular Toxicology*, 20(4), 159-166.
- Yokel, R.A., Lasley, S.M. & Dorman, D.C. (2006) The speciation of metals in mammals influences their toxicokinetics and toxicodynamics and therefore human health risk assessment(1). *Journal of Toxicology and Environmental Health. Part B, Critical Reviews*, 9(1), 63-85.

## 4. HUMAN SUSCEPTABILITY

No relevant papers identified.

## 5. TREATMENT AND IMAGING

Arbab, A.S., Liu, W. & Frank, J.A. (2006) Cellular magnetic resonance imaging: current status and future prospects. *Expert Rev Med Devices*, 3(4), 427-439.

Berkowitz, B.A., Roberts, R. & Goebel, D.J., *et al* (2006) Noninvasive and simultaneous imaging of layer-specific retinal functional adaptation by manganese-enhanced MRI. *Investigative Ophthalmology & Visual Science*, 47(6), 2668-2674.

Fitsanakis, V.A., Zhang, N. & Avison, M.J., *et al* (2006) The use of magnetic resonance imaging (MRI) in the study of manganese neurotoxicity. *Neurotoxicology*, 27(5), 798-806.

Nestle, N., Pauls, S. & Wunderlich, A. (2006) Oral magnetic resonance imaging contrast agent based on *Ilex paraguayensis* herbal extract. *Magnetic Resonance in Medicine*, 55(4), 923-929.

## 6. MISCELLANEOUS

Aschner, M., Lukey, B. & Tremblay, A. (2006) The Manganese Health Research Program (MHRP): status report and future research needs and directions. *Neurotoxicology*, 27(5), 733-736.

Winker, R. & Rudiger, H.W. (2006) Reproductive toxicology in occupational settings: an update. *International Archives of Occupational and Environmental Health*, V79(1), 1-10.