

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

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**June - August 2007**

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# Introduction

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This report presents the bibliographic details of papers identified as being first published during the period June to August 2007.

The papers were selected because they address research areas that are considered of direct relevance to the health effects of manganese (Mn); in order to aid review, the papers are presented under the following categories:

**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 - MECHANISM:** 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.

For the sake of completeness, this report also presents a number of papers that, although published before 2007, have not previously been identified in the databases routinely searched, and that have not been included in previous updates.

Future reports will present literature published during subsequent 3-monthly (quarterly) intervals.

# 1. EXPOSURE MEASUREMENT AND MODELLING

Choi, D.S., Kim, E.A., Cheong, H., *et al.* (2007) Evaluation of MR signal index for the assessment of occupational manganese exposure of welders by measurement of local proton T(1) relaxation time. *Neurotoxicology*, 28(2), 284-289.

## 2. HEALTH EFFECTS

Anonymous (2007) Manganese: Manganese toxicity following oral ingestion: Case report. *Reactions*, 1, 17.

Bouchard, M., Mergler, D., Baldwin, M., *et al.* (2007) Neuropsychiatric symptoms and past manganese exposure in a ferro-alloy plant. *Neurotoxicology*, 28(2), 290-297.

Bowler, R.M., Nakagawa, S., Drezgic, M., *et al.* (2007) Sequelae of fume exposure in confined space welding: A neurological and neuropsychological case series. *Neurotoxicology*, 28(2), 298-311.

de Bie, R.M.A., Gladstone, R.M., Strafella, A.P., *et al.* (2007) Manganese-induced parkinsonism associated with methcathinone (ephedrone) abuse. *Archives of Neurology*, 64(6), 886-889.

Finkelstein, M.M. & Jerrett, M. (2007) A study of the relationships between Parkinson's disease and markers of traffic-derived and environmental manganese air pollution in two Canadian cities. *Environmental Research*, 104(3), 420-432.

Hafeman, D., Factor-Litvak, P., Cheng, Z., *et al.* (2007) Association between manganese exposure through drinking water and infant mortality in Bangladesh. *Environmental Health Perspectives*, 115(7), 1107-1112.

Huang, C-C., Chu, N-S., Lu, C-S., *et al.* (2007) The natural history of neurological manganism over 18 years. *Parkinsonism & Related Disorders*, 13(3), 143-145.

Inoue, N. (2007) [Occupational neurotoxicology due to heavy metals-especially manganese poisoning]. *Brain Nerve*, 59(6), 581-589.

Kim, E.A., Cheong, H-K., Choi, D.S., *et al.* (2007) Effect of occupational manganese exposure on the central nervous system of welders: (1)H magnetic resonance spectroscopy and MRI findings. *Neurotoxicology*, 28(2), 276-283.

Kim, E.A., Cheong, H-K., Joo, K-D., *et al.* (2007) Effect of manganese exposure on the neuroendocrine system in welders. *Neurotoxicology*, 28(2), 263-269.

Rodríguez-Agudelo, Y., Riojas-Rodríguez, H., Ríos, C., *et al.* (2006) Motor alterations associated with exposure to manganese in the environment in Mexico. *The Science of the Total Environment*, 368(2-3), 542-556.

Sadek, A.H., Rauch, R. & Schulz, P.E. (2003) Parkinsonism due to manganism in a welder. *International Journal of Toxicology*, 22(5), 393-401.

Shin, Y.C., Kim, E., Cheong, H-K., *et al.* (2007) High signal intensity on magnetic resonance imaging as a predictor of neurobehavioral performance of workers exposed to manganese. *Neurotoxicology*, 28(2), 257-262.

Takser, L., Mergler, D., Hellier, G., *et al.* (2003) Manganese, monoamine metabolite levels at birth, and child psychomotor development. *Neurotoxicology*, 24(4-5), 667-674.

### 3. MECHANISM

- Aschner, M., Guilarte, T.R., Schneider, J.S., *et al.* (2007) Manganese: Recent advances in understanding its transport and neurotoxicity. *Toxicology and Applied Pharmacology*, 221(2), 131-147.
- Bredow, S., Falgout, M.M., March, T.H., *et al.* (2007) Subchronic inhalation of soluble manganese induces expression of hypoxia-associated angiogenic genes in adult mouse lungs. *Toxicology and Applied Pharmacology*, 221(2), 148-157.
- Casalino, E., Calzaretti, G., Landriscina, M., *et al.* (2007) The Nrf2 transcription factor contributes to the induction of alpha-class GST isoenzymes in liver of acute cadmium or manganese intoxicated rats: Comparison with the toxic effect on NAD(P)H:quinone reductase. *Toxicology*, 237(1-3), 24-34.
- Casalino, E., Sblano, C., Landriscina, V., *et al.* (2004) Rat liver glutathione S-transferase activity stimulation following acute cadmium or manganese intoxication. *Toxicology*, 200(1), 29-38.
- Crooks, D.R., Ghosh, M.C., Braun-Sommargren, M., *et al.* (2007) Manganese targets m-aconitase and activates iron regulatory protein 2 in AF5 GABAergic cells. *Journal of Neuroscience Research*, 85(8), 1797-1809.
- Crooks, D.R., Welch, N. & Smith, D.R. (2007) Low-level manganese exposure alters glutamate metabolism in GABAergic AF5 cells. *Neurotoxicology*, 28(3), 548-554.
- Deveci, E. (2006) Histopathological effects of organometallic maneb on testis in rats: A light and electron microscopic study. *Toxicology and Industrial Health*, 22(9), 395-398.
- Diaz-Veliz, G., Mora, S., Gomez, P., *et al.* (2004) Behavioral effects of manganese injected in the rat substantia nigra are potentiated by dicumarol, a DT-diaphorase inhibitor. *Pharmacology, Biochemistry, and Behavior*, 77(2), 245-251.
- Dobson, A.W., Weber, S., Dorman, D.C., *et al.* (2003) Oxidative stress is induced in the rat brain following repeated inhalation exposure to manganese sulfate. *Biological Trace Element Research*, 93(113-126)(14).
- Dodd, C.A., Ward, D.L. & Klein, B.G. (2005) Basal ganglia accumulation and motor assessment following manganese chloride exposure in the C57BL/6 mouse. *International Journal of Toxicology*, 24(6), 389-397.
- Dorman, D.C., McElveen, A.M., Marshall, M.W., *et al.* (2005) Maternal-fetal distribution of manganese in the rat following inhalation exposure to manganese sulfate. *Neurotoxicology*, 26(4), 625-632.
- Dorman, D.C., Struve, M.F., Gross, E.A., *et al.* (2005) Sub-chronic inhalation of high concentrations of manganese sulfate induces lower airway pathology in rhesus monkeys. *Respiratory Research*, 6(121).
- Elder, A., Gelein, R., Silva, V., *et al.* (2006) Translocation of inhaled ultrafine manganese oxide particles to the central nervous system. *Environmental Health Perspectives*, 114(8), 1172-1178.

- Erikson, K.M., Dorman, D.C., Lash, L.H., *et al.* (2005) Persistent alterations in biomarkers of oxidative stress resulting from combined in utero and neonatal manganese inhalation. *Biological Trace Element Research*, 104(2), 151-163.
- Erikson, K.M., Dorman, D.C., Lash, L.H., *et al.* (2007) Manganese inhalation by rhesus monkeys is associated with brain regional changes in biomarkers of neurotoxicity. *Toxicological Sciences*, 97(2), 459-466.
- Erikson, K.M., Dorman, D.C., Lash, L.H., *et al.* (2004) Airborne manganese exposure differentially affects end points of oxidative stress in an age- and sex-dependent manner. *Biological Trace Element Research*, 10049-62.
- Feng, S., Wang, X., Wei, G., *et al.* (2007) Leachates of municipal solid waste incineration bottom ash from Macao: Heavy metal concentrations and genotoxicity. *Chemosphere*, 67(6), 1133-1137.
- Huang, G-X. & Song, S-Z. (2007) Study on neurotoxic mechanism of manganese and the gene regulations. *Chinese Journal of Industrial Medicine*, 20(Part 2), 113-114.
- Kostial, K., Blanusa, M. & Piasek, M. (2005) Regulation of manganese accumulation in perinatally exposed rat pups. *Journal of Applied Toxicology*, 25(2), 89-93.
- Leavens, T.L., Rao, D., Andersen, M.E., *et al.* (2007) Evaluating transport of manganese from olfactory mucosa to striatum by pharmacokinetic modeling. *Toxicological Sciences*, 97(2), 265-278.
- Lewis, J., Bench, G., Myers, O., *et al.* (2005) Trigeminal uptake and clearance of inhaled manganese chloride in rats and mice. *Neurotoxicology*, 26(1), 113-123.
- Liao, S-L., Ou, Y-C., Chen, S-Y., *et al.* (2007) Induction of cyclooxygenase-2 expression by manganese in cultured astrocytes. *Neurochemistry International*, 50(7-8), 905-915.
- Milatovic, D., Yin, Z., Gupta, R.C., *et al.* (2007) Manganese induces oxidative impairment in cultured rat astrocytes. *Toxicological Sciences*, 98(1), 198-205.
- Montes, S., Alcaraz-Zubeldia, M., Muriel, P., *et al.* (2003) Role of manganese accumulation in increased brain glutamine of the cirrhotic rat. *Neurochemical Research*, 28(6), 911-917.
- Muggenburg, B.A., Benson, J.M., Barr, E.B., *et al.* (2003) Short-term inhalation of particulate transition metals has little effect on the electrocardiograms of dogs having preexisting cardiac abnormalities. *Inhalation Toxicology*, 15(4), 357-371.
- Nielsen, B.S., Larsen, E.H., Ladefoged, O., *et al.* (2006) Neurotoxic effect of maneb in rats as studied by neurochemical and immunohistochemical parameters. *Environmental Toxicology and Pharmacology*, 21(3), 268-275.
- Norenberg, M.D. & Rao, K.V.R. (2007/6) The mitochondrial permeability transition in neurologic disease. *Neurochemistry International*, 50(7-8), 983-997.
- Normandin, L., Beaupre, L.A., Salehi, F., *et al.* (2004) Manganese distribution in the brain and neurobehavioral changes following inhalation exposure of rats to three chemical forms of manganese. *Neurotoxicology*, 25(3), 433-441.
- Normandin, L., Carrier, G., Gardiner, P.F., *et al.* (2002) Assessment of bioaccumulation, neuropathology, and neurobehavior following subchronic (90 days) inhalation in Sprague-

Dawley rats exposed to manganese phosphate. *Toxicology and Applied Pharmacology*, 183(2), 135-145.

Park, J-D., Kim, K-Y., Kim, D-W., *et al.* (2007) Tissue distribution of manganese in iron-sufficient or iron-deficient rats after stainless steel welding-fume exposure. *Inhalation Toxicology*, 19(6), 563-572.

Pecze, L., Papp, A. & Nagymajtenyi, L. (2004) Changes in the spontaneous and stimulus-evoked activity in the somatosensory cortex of rats on acute manganese administration. *Toxicology Letters*, 148(1-2), 125-131.

Perl, D.P. & Olanow, C.W. (2007) The neuropathology of manganese-induced parkinsonism. *Journal of Neuropathology & Experimental Neurology*, 66(8), 675-682.

Ponnappakkam, T., Iszard, M. & Henry-Sam, G. (2003) Effects of oral administration of manganese on the kidneys and urinary bladder of Sprague-Dawley rats. *International Journal of Toxicology*, 22(3), 227-232.

Ponnappakkam, T.P., Bailey, K.S., Graves, K.A., *et al.* (2003) Assessment of male reproductive system in the CD-1 mice following oral manganese exposure. *Reproductive Toxicology*, 17(5), 547-551.

Ponnappakkam, T.P., Sam, G.H. & Iszard, M.B. (2003) Histopathological changes in the testis of the Sprague-Dawley rat following orally administered manganese. *Bulletin of Environmental Contamination and Toxicology*, 71(6), 1151-1157.

Rama Rao, K.V., Reddy, P.V.B., Hazell, A.S., *et al.* (2007) Manganese induces cell swelling in cultured astrocytes. *NeuroToxicology*, 28(4), 807-812.

Roth, J.A. (2007) Environmental, biochemical and molecular factors regulating manganese-induced neurological injury. *Journal of Organ Dysfunction*, 3(2), 110-122.

Sengupta, A., Mense, S.M., Lan, C., *et al.* (2007) Gene expression profiling of human primary astrocytes exposed to manganese chloride indicates selective effects on several functions of the cells. *Neurotoxicology*, 28(3), 478-489.

Skebo, J.E., Grabinski, C.M., Schrand, A.M., *et al.* (2007) Assessment of metal nanoparticle agglomeration, uptake, and interaction using high-illuminating system. *International Journal of Toxicology*, 26(2), 135-141.

Sun, F., Kanthasamy, A., Anantharam, V., *et al.* (2007) Environmental neurotoxic chemicals-induced ubiquitin proteasome system dysfunction in the pathogenesis and progression of Parkinson's disease. *Pharmacology & Therapeutics*, 114(3), 327-344.

Sung, J.H., Choi, B-G., Maeng, S-H., *et al.* (2004) Recovery from welding-fume-exposure-induced lung fibrosis and pulmonary function changes in Sprague-Dawley rats. *Toxicological Sciences*, 82(2), 608-613.

Torrente, M., Colomina, M.T. & Domingo, J.L. (2002) Effects of prenatal exposure to manganese on postnatal development and behavior in mice: Influence of maternal restraint. *Neurotoxicology and Teratology*, 24(2), 219-225.

Tran, T.T., Chowanadisai, W., Lönnerdal, B., *et al.* (2002) Effects of neonatal dietary manganese exposure on brain dopamine levels and neurocognitive functions. *Neurotoxicology*, 23(4-5), 645-651.



Weber, S., Dorman, D.C., Lash, L.H., *et al.* (2002) Effects of manganese (Mn) on the developing rat brain: Oxidative-stress related endpoints. *Neurotoxicology*, 23(2), 169-175.

Yang, H., Sun, Y. & Zheng, X. (2007) Manganese-induced apoptosis in rat myocytes. *Journal of Biochemical and Molecular Toxicology*, 21(3), 94-100.

Zhang, S., Zhou, Z. & Fu, J. (2003) Effect of manganese chloride exposure on liver and brain mitochondria function in rats. *Environmental Research*, 93(2), 149-157.

## **4. HUMAN SUSCEPTIBILITY**

No relevant papers identified.

## 5. TREATMENT AND IMAGING

Choi, D.S., Kim, E.A., Cheong, H-K., *et al.* (2007) Evaluation of MR signal index for the assessment of occupational manganese exposure of welders by measurement of local proton T(1) relaxation time. *Neurotoxicology*, 28(2), 284-289.

Kim, E.A., Cheong, H-K., Choi, D.S., *et al.* (2007) Effect of occupational manganese exposure on the central nervous system of welders: (1)H magnetic resonance spectroscopy and MRI findings. *Neurotoxicology*, 28(2), 276-283.

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## 6. MISCELLANEOUS

Michalke, B., Halbach, S. & Nischwitz, V. (2007) Speciation and toxicological relevance of manganese in humans. *Journal of Environmental Monitoring*, 9(7), 650-656.

Spiegel-Ciobanu, V.E. & McMillan, G. (2007) Manganism, Parkinson's disease and welders' occupational exposure to manganese - Part 1: Sources of manganese exposure and its role and function in human health and disease. *Welding and Cutting*, 6(3), 161-165.