IEH Institute of Environment and Health

Cranfield UNIVERSITY

Manganese Health Research Program: Recent published literature

June 2007 - August 2008

September 2008

The Institute of Environment and Health (IEH) was established at Cranfield University in November 2005. The research and consultancy activities of the Institute are principally funded through specific grants, contracts and awards by UK Government Departments and Agencies.

This document is a report by the Institute of Environment and Health for the Manganese Health Research Program (MHRP)

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Introduction

This report presents the bibliographic details of papers identified as being first published during the period June 2007 to August 2008.

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.

1. EXPOSURE MEASUREMENT AND MODELLING

Baldwin, M. (2008) Past Occupational Exposure to Airborne Manganese in a Manganese Alloy Plant. *Journal of Occupational and Environmental Hygiene,* 5(7), 426-437.

Cowan, D.M., Fan, Q., Zou, Y.*, et al* (2008) *Manganese Exposure in 328 Smelting Workers: Relationship among External/ Internal Markers and Neurological/Psychomotor Examinations*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Maduabuchi, J.M.U., Nzegwu, C.N., Adigba, E.O.*, et al.* (2008) Iron, Manganese and Nickel Exposure from Beverages in Nigeria: A Public Health Concern? *Journal of Health Science,* 54(3), 335-338.

2. HEALTH EFFECTS

Bouchard, M., Mergler, D., Baldwin, M.E.*, et al.* (2008) Manganese Cumulative Exposure and Symptoms: A Follow-Up Study of Alloy Workers. *NeuroToxicology,* 29(4), 577-583.

Cowan, D.M., Fan, Q., Zou, Y.*, et al* (2008) *Manganese Exposure in 328 Smelting Workers: Relationship among External/ Internal Markers and Neurological/Psychomotor Examinations*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Elbaz, A. & Moisan, F. (2008) Update in the Epidemiology of Parkinson's Disease. *Current Opinion in Neurology,* 24(4), 454-460.

Goodman, J.E., Bailey, L.A. & Beck, B.D. (2008) *Recent Studies of the Health Effects of Manganese and the Implications for the Reference Concentration (RFC).* Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Jing, J. & Xie, J. (2008) Hazards of Manganese Pollution to Health. *Guangdong Weiliang Yuansu Kexue,* 15(NUMB 2), 6-9.

Winder, B., Morry, D., Salmon, A.*, et al* (2008) *Manganese and the Development of Reference Exposure Levels to Protect Against 8-Hour and Chronic Exposures*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Wittczak, T., Dudek, W., Krakowiak, A.*, et al.* (2008) Occupational Asthma due to Manganese Exposure: A Case Report. *International Journal of Occupational Medicine and Environmental Health,* 21(1), 81-83.

3. MECHANISM

Anderson, J. & Erikson, K. (2008) *Manganese Exposure Alters GABA and Norepinephrine Transporter Protein Expression in the Developing Rat Brain*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Au, C., Benedetto, A. & Aschner, M. (2008) *Investigation of Manganese Transport in C. Elegans*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Au, C., Benedetto, A. & Aschner, M. (2008) Manganese Transport in Eukaryotes: The Role of DMT1. *NeuroToxicology,* 29(4), 569-576.

Benedetto, A., Au, C. & Aschner, M. (2008) *Investigation of Manganese Toxicity in PD Genes Deficient C. Elegans*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Burton, N.C., Schneider, J.S. & Guilarte, T.R. (2008) *Effects of Chronic Manganese Exposure on Glutamatergic markers in the Non-Human Primate Brain*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Crittenden, P.L., Lee, S. & Filipov, N.M. (2008) *Potentiation of Proinflammatory Cytokines by Manganese in LPS-Activated Microglia is Associated with Decreased Expression and Activity of Mitogen Associated Protein Kinase Phosphatase-1*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Deng, Y., Xu, D-h. & Xu, B. (2008) Study on Neurotoxicity Mechanism Induced by Manganese Chloride in Rats. *Chinese Journal of Industrial Medicine,* 21(PART 2), 103-105.

Erikson, K.M., Dorman, D.C., Lash, L.H.*, et al.* (2008) Duration of Airborne-Manganese Exposure in Rhesus Monkeys is Associated with Brain Regional Changes in Biomarkers of Neurotoxicity. *Neurotoxicology,* 29(3), 377-385.

Filipov, N.M., Crittenden, P.L. & Lee, S. (2008) *Potential Role of Microglia in Manganese Neurotoxicity*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Grillon, E., Provent, P., Montigon, O.*, et al.* (2008) Blood-Brain Barrier Permeability to Manganese and to Gd-DOTA in a Rat Model of Transient Cerebral Ischaemia. *NMR in Biomedicine,* 21(5), 427-436.

Guilarte, T.R., Burton, N.C., Verina, T.*, et al.* (2008) Increased APLP1 Expression and Neurodegeneration in the Frontal Cortex of Manganese-Exposed Non-Human Primates. *Journal of Neurochemistry,* 105(5), 1948-1959.

Herken, E.N., Kocamaz, E., Kucukatay, M.B.*, et al.* (2008) Ceruloplasmin, Copper, Selenium, Iron, Zinc, and Manganese Levels in Normal and Sulfite Oxidase Deficient

Rat Plasma: Effects of Sulfite Exposure. *Biological Trace Element Research,* 123(1-3), 202-210.

Itoh, K., Sakata, M., Watanabe, M.*, et al.* (2008) The Entry of Manganese Ions into the Brain is Accelerated by the Activation of N-Methyl-d-Aspartate Receptors. *Neuroscience,* 154(2), 732-740.

Jia, K., Xu, Z-f. & Xu, B. (2008) Effects of Manganese on Glutamate Metabolism and Enzyme Activities in Brain of Rats. *Chinese Journal of Public Health -Shenyang-,* 24(3), 0346-0347.

Jiang, H., Yin, Z. & Aschner, M. (2008) *Antioxidants Reduce Manganese-Induced Mitochondrial Impairment in Cultured Astrocytes*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Kalia, K., Jiang, W. & Zheng, W. (2008) *Manganese Primarily Accumulates in Nucleus of Cultured Brain Cells.* Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Kern, C. & Smith, D. (2008) Developmental Manganese Exposures Produce Neurobehavioral Deficits Associated with Altered Dopamine receptor/transporter Expression. *Neurotoxicology and Teratology,* 30(3), 259. Presented at Thirty-second Annual Meeting of the Neurobehavioral Teratology Society, June 28–July 2, 2008, Monterey, CA.

Lee, E.Y., Jiang, H., Yin, Z.*, et al* (2008) *Mechanisms of Estrogen-Mediated Neuroprotection in Manganese-Induced Neurotoxicity*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Liapi, C., Zarros, A., Galanopoulou, P.*, et al.* (2008) Effects of Short-Term Exposure to Manganese on the Adult Rat Brain Antioxidant Status and the Activities of Acetylcholinesterase, (Na,K)-ATPase and Mg2-ATPase: Modulation Byl-Cysteine. *Basic & Clinical Pharmacology & Toxicology,* 103(2), 171-175.

Lima, P.D., Vasconcellos, M.C., Bahia, M.O.*, et al.* (2008) Genotoxic and Cytotoxic Effects of Manganese Chloride in Cultured Human Lymphocytes Treated in Different Phases of Cell Cycle. *Toxicology in Vitro,* 22(4), 1032-1037.

Liu, B., Liu, Y., Dutta, G.*, et al* (2008) *Characterization of Manganese-Induced Production of Reactive Oxygen Species in Microglia: Relevance to Dopaminergic Neurodegeneration*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Maher, T. & Phattanarudee, S. (2008) Effects of in Utero and Lactational Manganese Exposure on Behavioral and Neurochemical Outcomes in Rats. *Neurotoxicology and Teratology,* 30(3), 252-252. Presented at Thirty-second Annual Meeting of the Neurobehavioral Teratology Society, June 28–July 2, 2008, Monterey, CA.

McDougall, S.A., Reichel, C.M., Farley, C.M.*, et al.* (2008) Postnatal Manganese Exposure Alters Dopamine Transporter Function in Adult Rats: Potential Impact on Nonassociative and Associative Processes. *Neuroscience,* 154(2), 848-860.

McGlothan, J.L., Burton, N.C., Zhou, Y.*, et al* (2008) *Neuroimaging of Dopaminergic Synapses in the Striatum of Manganese-Exposed Non-Human Primates*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Nong, A., Dorman, D.C., Clewell, H.J.*, et al* (2008) *Assessing Factors Important for Tissue Accumulation of Manganese in Monkeys by Pharmacokinetic Modeling*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Ordoñez-Librado, J.L., Gutierrez-Valdez, A.L., Colín-Barenque, L.*, et al.* (2008) Inhalation of Divalent and Trivalent Manganese Mixture Induces a Parkinson's Disease Model: Immunocytochemical and Behavioral Evidences. *Neuroscience,* 155(1), 7-16.

Petrov, A.N. (2008) *Study of Influence of Combined Introduction of Manganese and Piracetam on Cognitive Functions in White Rats*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Phillips, K., Cooney, P. & Erikson, K. (2008) *The Effect of Manganese Accumulation on Glutathione Metabolism in Rat Liver Subcellular Fractions*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Prabhakaran, K., Ghosh, D., Chapman, G.D.*, et al.* (2008) Molecular Mechanism of Manganese Exposure-Induced Dopaminergic Toxicity. *Brain Research Bulletin,* 76(4), 361-367.

Rousselet, E., Richaud, P., Douki, T.*, et al.* (2008) A Zinc-Resistant Human Epithelial Cell Line is Impaired in Cadmium and Manganese Import. *Toxicology and Applied Pharmacology,* 230(3), 312-319.

Stankowski, J., Leitch, D., Aschner, M.*, et al* (2008) Selective Vulnerability of Dopaminergic Systems to Manganese: Relevance to Occupational Exposure. *Neurotoxicology and Teratology,* 30(3), 259. Presented at Thirty-second Annual Meeting of the Neurobehavioral Teratology Society, June 28–July 2, 2008, Monterey, CA.

Sullivan, K.A., Streifel, K., Moreno, J.A.*, et al* (2008) *Neuropathological Analysis of Glial Inflammatory Responses to Manganese-Induced Neurotoxicity in Developing Mice*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Verina, T., Schneider, J.S. & Guilarte, T.R. (2008) *Manganese Exposure Induces Alzheimers - Like Pathology in the Frontal Cortex of Non-Human Primates*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Wang, J., Rahman, M.F., Duhart, H.M.*, et al* (2008) *Expression Changes of Dopaminergic System-Related Genes in PC12 Cells Induced by Mn, Ag, Or Cu Nanoparticles*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Wang, X., Zhang, Y. & Zheng, W. (2008) *Iron Clearance in the Cerebrospinal (CSF) of Rat Brains as Affected by Manganese Exposure by Ventriculo-Cisternal Brain Perfusion*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Wang, X., Miller, D.S. & Zheng, W. (2008) Intracellular Localization and Subsequent Redistribution of Metal Transporters in a Rat Choroid Plexus Model Following Exposure to Manganese Or Iron. *Toxicology and Applied Pharmacology,* 230(2), 167-174.

Wu, S-l., Guo, S-c. & Qin, X. (2008) Effect of Taurine on Active Calmodulin Content of the Striatum Tissue in Manganese Exposed Rats. *Industrial Health and Occupational Diseases -Beijing-,* 34(2), 65-67.

Yeomans, C., Moreno, J.A., Sullivan, K.A.*, et al* (2008) *Developmental Vulnerability to Manganese-Induced Behavioral Dysfunction*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Yin, Z., Milatovic, D., Rocha, J.*, et al* (2008) *Ebselen Attenuates Manganese-Induced Oxidative Injury in Rat Primary Astrocytes*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Zhang, Y. & Zheng, W. (2008) *Altered Copper Transport at Rat Blood-CSF Barrier Following Subchronic Exposure to Manganese*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

Zhang, X-p., Wang, Q-x. & Cai, X-l. (2008) Effect of Manganese on Apoptosis in Spermatogenic Cell of Rats. *Industrial Health and Occupational Diseases -Beijing-,* 34(2), 85-88.

Zhao, P., Zhong, W., Ying, X.*, et al.* (2008) Manganese Chloride-Induced G0/G1 and S Phase Arrest in A549 Cells. *Toxicology,* 250(1), 39-46.

4. HUMAN SUSCEPTIBILITY

No relevant papers identified.

5. TREATMENT AND IMAGING

Zheng, W., Zhang, Y., Jiang, Y.*, et al* (2008) *Removal of Tissue Manganese by p-Aminosalicylic Acid (PAS) in Manganese-Exposed Rats in Vivo*. Presented at the 47th Annual Meeting of the Society of Toxicology (SOT 2008), Seattle, Washington (USA), 16-20 March 2008.

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6. MISCELLANEOUS

Chan, D. (2008) Developing a Child-Specific Reference Dose for Manganese for use in School Site Risk Assessment. *Neurotoxicology and Teratology,* 30(3), 259. Presented at Thirty-second Annual Meeting of the Neurobehavioral Teratology Society, June 28–July 2, 2008, Monterey, CA.

Rohlman, D.S., Lucchini, R., Anger, W.K.*, et al.* (2008) Neurobehavioral Testing in Human Risk Assessment. *NeuroToxicology,* 29(3), 556-567.