

## **FORMALDEHYDES**

### **Symptoms**

Aldehydes have been associated with illness symptoms including headache, eye and respiratory irritation, sleep disturbance and increased thirst in workers with occupational exposure as well as people with certain consumer products at exposure levels as low as 0.13 ppm.<sup>1</sup> Chronic exposure to formaldehyde can cause asthmatic symptoms and other reactive airway disease,<sup>2</sup> headache, memory loss, dizziness, upper and lower airway effects, aching, gastrointestinal disturbances, chronic fatigue, and increased sensitivity to chemicals.<sup>3 4 5</sup>

A daycare worker exposed to levels of 0.43 mg/m<sup>1</sup> (about .034 ppm) experienced headache, eye and respiratory irritation and fatigue.<sup>6</sup> Boeing workers exposed to formaldehyde resins had fatigue, impaired memory, headache, confusion and respiratory effects.<sup>7</sup> A home resident exposed to formaldehyde (UFFI insulation) developed respiratory problems and new onset of sensitivity to chemicals.<sup>8</sup>

### **Immune Effects**

Immune changes have also been reported with formaldehyde exposure. Changes in cell-mediated immunity can include changes in basophiles and/or suppressor cells.<sup>9</sup> Chronically ill persons after formaldehyde exposure often exhibit immune activation and increased auto antibodies.<sup>18</sup> Mobile home residents with chronic exposure at 0.05 to 0.5 ppm exhibited increased immune activation (increased TA1), increased auto antibodies, and (as a group) increased antibodies against formaldehyde (anti HCHO-HSA).<sup>8</sup> Another mobile home group with exposures of 0.07 to 0.55 ppm found reduced T lymphocytes and impaired T cell function using PHA.<sup>3</sup> However, since immune responses change with the time lapse from the initiating exposure, the individual patient abnormalities will be in part determined by how soon they were tested following the causal exposure.

### **Liver Effects**

Liver effects can also develop from formaldehyde exposure.<sup>4</sup> These include toxic hepatitis and symptoms of hypersensitivity which developed in a family exposed up to 0.95 ppm; a 10 year old who developed jaundice and liver enzyme changes with exposures in a mobile home up to 10ppm; and home occupant exposed to 10 ppm who developed hepatitis, respiratory problems and a newly induced sensitivity to chemicals.

### **Reactive Airways**

Formaldehyde stimulates the brain vanilloid receptor.<sup>10</sup> This receptor induces sensitization by increasing nitric oxide and activating the NMDA receptor,<sup>11</sup> which then increases peroxynitrite and sets in motion neural sensitization. Vanilloid stimulation also increases release of immune substance P.<sup>12</sup> Increased substance P is associated with reactive airway disease.<sup>13</sup>

## **Brain Changes**

An epidemiologic study of 305 histology technicians compared to controls showed that their formaldehyde exposure was significantly associated with neurocognitive impairment affecting memory, attention span, balance, etc.<sup>14</sup> Exposure levels in the areas of greatest exposure were 0.2 to 1.9 ppm, but technicians did not spend the full day in these areas.

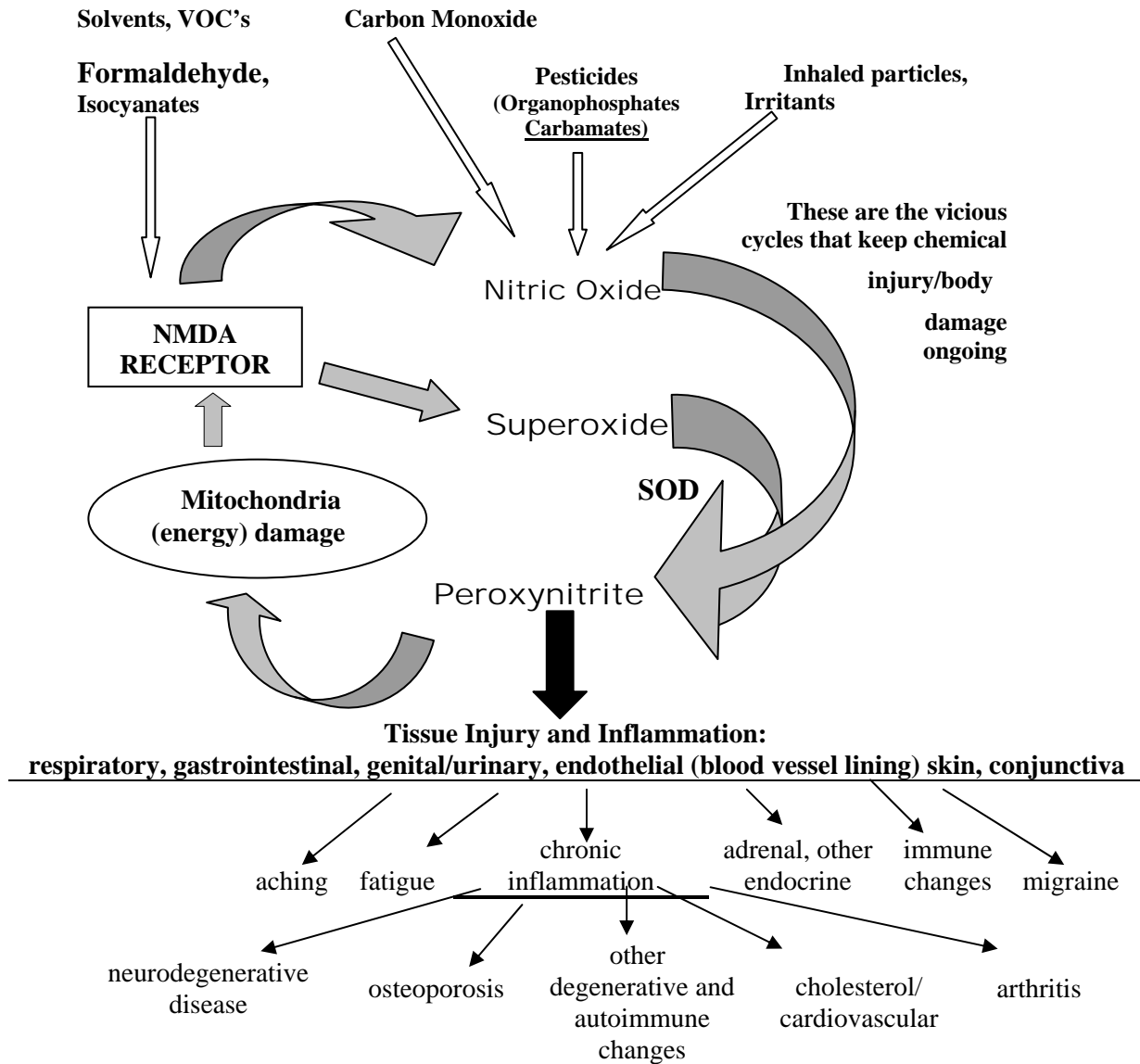
Another study of formaldehyde-exposed employees<sup>15</sup> showed excess fatigue, headache, sleep disturbance, irritability and mood changes. Neurologic functions were impaired also on testing, including balance, reaction time, color visual fields and multiple tests of cognitive function. These persons were examined four years or longer after last exposure; therefore changes demonstrate long standing impaired brain function.

Insulators using formaldehyde-containing insulation<sup>16</sup> were found to have impairment on lung function compared to controls, including worse FEV1, FEV75-85 (small airway disease), vital capacity (FVC) and/or gas transfer ability (diffusing capacity).

Formaldehyde can cause nervous system damage by its known ability to react with and form cross proteins, DNA and brain and cell membrane lipids.<sup>5</sup> These same mechanisms could damage virtually any cell in the body, since all cells contain these substances. Formaldehyde can react with the nerve proteins (neuroamines) and nerve transmitters (e.g., catecholamines),<sup>5</sup> which could impair normal nervous system function and cause endocrine disruption.

Exposure to formaldehyde can cause sensitization. This leads to abnormal responses both to low levels of formaldehyde and to multiple other chemicals.<sup>17</sup>

## NEURAL SENSITIZATION: VICIOUS BIOCHEMICAL CYCLES



- <sup>1</sup> NIOSH Criteria for a Recommended Standard: Occupational Exposure to Formaldehyde. USDHEW, Dec 1976.
- <sup>2</sup> H Nordman, *et al.*, "Formaldehyde asthma - rare or overlooked?" *J. Allergy Clin Immunol* 75:81-99, 1985.
- <sup>3</sup> A Broughton, JD Thrasher "Antibodies and altered cell mediated immunity in formaldehyde exposed humans," *Comments Toxicol* 2:155-170, 1988.
- <sup>4</sup> JD Thrasher *et al.* "Building related illness and antibodies to albumin conjugates of formaldehyde, toluene diisocyanate and trimellitic anhydride", *Amer J. Ind. Med* 15:187-195, 1989.
- <sup>5</sup> JD Thrasher *et al.*, "Immune activation and auto antibodies in humans with long-term inhalation exposure to formaldehyde," *Archive Environ Health* 45: 217-223, 1990.
- <sup>6</sup> JH Olsen *et al.*, "Formaldehyde induced symptoms in day care centers," *Am Ind. Hyg Assoc. J.* 43:366-370, 1982.
- <sup>7</sup> LC Grammer, *et al.*, "Clinical and immunologic evaluation of 37 workers exposed to gaseous formaldehyde," *J. Allergy Clin. Immun* 86:177-181, 1990.
- <sup>8</sup> JD Thrasher *et al.*, "Antibodies and immune profiles of individuals occupationally exposed to formaldehyde: six case reports," *Amer J. Ind. Med.* 14:479-488, 1988.

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- <sup>9</sup> HF Pross etal. "Immunologic studies of subjects with asthma exposed to formaldehyde and area-formaldehyde (UFFI) off-products." J. Allergy Clin Immuno 79:787-810, 1987.
- <sup>10</sup> A Beiruth etal., "Spinal and surpaspinal antinociceptive action of dipyrone in formalin, capsaicin and glutamate tests. Study of the mechanism of action," Environ J Pharmacol 345: 233-45, 1998.
- <sup>11</sup> E Palazzo etal., "Interaction between vanilloid and glutamate receptors in the central modulation of nociception", Environ J Pharmacol 439: 69-75, 2002.
- <sup>12</sup> H Kimata etal., "Effect of exposure to volatile organic compounds on plasma levels of neuropeptides, nerve growth factor and histamine in patients with chemical sensitivity", Int J Hyg Environ Health 207: 159-63, 2004.
- <sup>13</sup> WJ Meggs, "The toxic induction of asthma and rhinitis", Clinical Toxicol 32:487-501, 1994.
- <sup>14</sup> KH Kilburn, "Formaldehyde impairs memory, equilibrium and dexterity in histology technicians", Archiv Environ 42:117, 1987.
- <sup>15</sup> KH Kilburn, "Neurobehavioral impairment and seizures from formaldehyde", Archiv Environ Health 49: 37-44, 1994.
- <sup>16</sup> KH Kilburn, "Pulmonary and neurobehavioral effects of formaldehyde exposure", Archiv Environ Health 40:254-260, 1985.
- <sup>17</sup> R Wiglusz etal., "Effect of environmental conditions on re-emission of formaldehyde from textile materials", Bull Inst. Marit Trop Med Gdyni 46:53-58, 1945.