TOXIC ENCEPHALOPATHY

The brain is more susceptible to damage from chemical injury. It has a high proportion of polyunsaturated forming myelin; these are at great risk of damage with exposure to chemical breakdown products called free radicals.¹

The brain also has special vulnerability to toxic damage, due to the following factors:²

- long shape of nerve cells require a supply line that is highly vulnerable to toxic chemicals;
- impaired energy metabolism and/or reduced oxidative metabolism increases risk of nerve cell damage;
- brain cells are unable to regenerate and damage/cell loss is usually permanent;
- the high metabolic rate of the brain cells render them more susceptible as even brief (even minutes) adverse changes in brain metabolism can cause brain cell death promptly;
- there is no barrier to keep toxins out of the brain when breathed in through the nose;
- relatively small losses of neurons which use acetylcholine or dopamine as neurotransmitters can cause, respectively, profound reductions in memory or coordination;

Many petrochemical compounds have been shown to cause chronic changes in brain function verified by testing.³⁴⁵⁶⁷⁸⁹¹⁰¹¹ Lipid soluble chemicals pass the blood brain barrier easily¹⁰ and so more readily enter the brain.¹⁰ Brain changes are accompanied by persisting chronic symptoms including headache, fatigue, weakness, balance disturbance, impaired coordination, reduced memory, attention span and concentration and mood and personality changes.⁶⁷⁸⁹¹⁰¹² Even low-level exposure to volatile organic compounds can cause changes in brain function.¹³ This study was a study of the acute short-term effects, but intermittent repeated exposures have been documented as capable of causing neural (brain) sensitization via the mechanism of time dependent sensitization.¹⁴¹⁵ Brain damage can occur even following relatively short-term exposure to hydrocarbon/petrochemical compounds, which can also induce cacosmia (symptom changes in response to chemical odors).¹⁶ Toxic induced brain damage can induce chemical intolerance.¹⁷ Other studies document brain changes with low level chronic exposure.¹⁸,¹⁹,²⁰,²¹ Further exposure after brain damage begins causes further damage.²² Individuals with toxic encephalopathy often have long-term or permanent brain damage, which creates severe impairment in their ability to function.²³

Toxic exposure which leads to the formation of antibodies to the brain/nervous system leads to changes in the neuromuscular function.²⁴

Long term exposure to organic solvents can induce toxic encephalopathy with chronic persisting symptoms of fatigue (90%), impaired short term memory (94%), reduced concentration (88%), irritability (84%), headaches (81%) and other neuropsychiatric effects.²⁵,²⁶ The means by which various chemical compounds cause chronic brain effects include their solubility in fatty tissue which is highly prevalent in the brain, the high rate of blood flow in the brain, and the ability of solvents and other petrochemicals to attack the nerve cell membranes and energy metabolism as well as creating toxic metabolites and causing disturbances in the detoxification system.²⁷ Petrochemical substances being lipid soluble are taken up into the brain and concentrate in the lipid part of the brain including but not limited to the brain stem.²⁸ Toxic chemical compounds are also capable of entering the brain directly through the nose.²⁹ SPECT brain scans on adults with chronic symptoms following a history of toxic exposure to mixed petrochemical solvents compared to
healthy controls showed reduced ability to take up the tracer substance in the early phase of injection. Increased tracer was found in the late phase of injection, consistent with impaired detoxification ability and/or reduced blood flow. Changes were seen in frontal, temporal and limbic brain areas. Persons with toxic encephalopathy can develop limbic hypermetabolism documented on PET scans, associated with chemical intolerance. Types of exposures causing brain damage in this study included industrial exposures and accidents, “tight” sick office building exposure and environmental overexposure.

SPECT scans show reduced blood flow to the brain in toxic encephalopathy. Brain cells (neurons) need high blood flow and oxygen needs, and reduced flow easily damages their function. These brain cells are readily damaged by reduced energy metabolism, a common finding in chemically injured patients.

Chemicals breathed in enter the limbic system, which then affects the hypothalamus and pituitary, and through pituitary control, adrenal, thyroid and reproductive function.

Persisting brain damage can be caused by symptomatic exposure (repeated or single acute) to combustion products, pesticides, solvents, volatile organic compounds (VOC’S), chlorine (inorganic and organic chlorines), hydrogen sulfide and a very wide range of petrochemicals. Without treatment, including but not limited to environmental controls to reduce future exposure, there is often no improvement and deterioration can occur. Chronic toxic encephalopathy is long lasting brain structural damage or brain dysfunction secondary to an exposure from a chemical or mixture of chemicals interfering with brain function. The International Classification of Disease (ICD) code for toxic encephalopathy is 349.82. This is a universally accepted diagnosis for this condition.

Toxic petrochemicals are excreted using Phase I and II detoxification. Phase II detoxification requires a lot of energy from the body's energy stores, thus causing significant further fatigue. Phase II detoxification also requires nutritional cofactors, which must be replaced because they attached to the toxin and depleted.

Petrochemical toxins generate increased free radicals in Phase I, which damage the energy generating mitochondria, thus leading to less energy for Phase II and increased tissue damage from Phase I free radicals which cannot be detoxified adequately in Phase II. Nutrients necessary for energy production (in the body's mitochondria) include adequate thiamine (B1), riboflavin (B2), niacin (B3), pantothenic acid (B5) and magnesium. Nutrients needed to help protect from free radical damage (also called oxidative stress) of Phase I include adequate antioxidants and other detoxification co-factors, including but not limited to vitamins C, E, Zinc, Selenium and Copper.

Nutrients necessary for Phase II detoxification include cobalamin (B12), folate, methionine, choline, N-acetylcysteine, glutathione, sulfate (in natural form).

Brain ischemia (reduced oxygen/blood supply) can lead to increased free radicals, death of brain cells and neurodegenerative disease. Increased free radicals cause increased risk of neurodegenerative disease such as Parkinson's, AML, Altzimers and increased brain aging. Accelerated neurodegenerative disease occurs from increased oxidative stress such as from chemical exposure. Increased lipid peroxides is an indicator of brain and cellular membrane lipid damage. Free radicals from chemicals damage cellular and other body membranes, resulting in reduced polyunsaturated lipids (omega 3’s), making membranes less flexible, and makes them more
permeable to undesired amounts of substances.\textsuperscript{41} This leads to further damage and death to brain cells and energy-generating structures called mitochondria.\textsuperscript{41}

Free radicals also attack proteins, (including but not limited to body enzymes, proteins which transport minerals and other vital nutrients and proteins needed for body repair).\textsuperscript{41} Free radicals also damage DNA and RNA, producing more damaged DNA products such as 8-oxo-2\textsuperscript{-}deoxyguanosine), a marker of DNA damage.\textsuperscript{41}

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HOW YOUR BODY RESPONDS TO CHEMICALLY-INDUCED PAIN AND INFLAMMATION