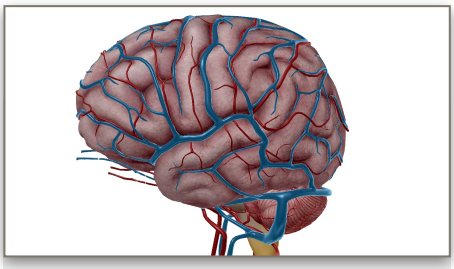
CHEMICAL-INDUCED BRAIN INJURY

IN OCCUPATIONAL EXPOSURE CASES



Blood-Brain Barrier

About 100 years ago, a German-Jewish physician experimenting with various dyes noticed that if you injected a particular blue dye in an animal, all of the internal organs would turn blue, except for the brain. This observation led to the discovery of a semi-permeable membrane in the blood vessels of the brain that prevents pathogens and large molecules in the bloodstream from passing into the cerebral fluid. Some small molecules (e.g., certain organic solvents) are able to penetrate the barrier.

Primary Brain Cancer?

Can chemical exposures produce a *primary* brain cancer? The short answer is "Not as far as we know". One effect of the Blood-Brain Barrier is that it prevents chemical carcinogens from entering the brain and producing primary tumors. *"Other than radiation, no known lifestyle-related or environmental factors are clearly linked to brain tumors. Most gene changes are probably just random*

Toxic Encephalopathy

Encephalopathy is a broad term that refers to any disease of the brain that alters brain function or structure. There are many types of encephalopathies, and they are usually differentiated by their cause. *Metabolic Encephalopathy* results from systemic illness, such as diabetes, liver disease, renal failure and heart failure. *Chronic Traumatic Encephalopathy* results from multiple traumas or injuries to the brain. ***Toxic Encephalopathy*** results from the brain's interaction with certain toxic chemicals or agents.

Diagnosing Toxic Encephalopathy

Most often, a distinguishing feature of Toxic Encephalopathy is that the neurological symptoms - *for example, numbness in the hands or feet* - are symmetrical. If only one hand, or one side of the body is affected, then odds are its not toxin-related. Other symptoms can include memory loss, lethargy, decreased concentration and consciousness, muscle twitching or tremors, sleep apnea, and subtle personality changes. In more severe cases, the symptoms can include dementia, seizures, coma and death.

Since organ failure can release neurotoxins into the bloodstream, it is important to eliminate advanced diabetes, liver failure, renal failure, and heart failure as possible causes (i.e., eliminate Metabolic Encephalopathy as a cause).

In some instances, relatively contemporaneous blood tests, liver function studies, and urine tests can confirm the nature and extent of the exposure, and support the diagnosis, by identifying the biomarkers produced by certain chemicals. For example, the primary urinary metabolite of Toluene is hippuric acid, which can be biologically monitored.

An ***acute*** exposure to certain organic solvents, some gases (e.g., carbon monoxide, hydrogen sulfide and carbon disulfide), metal vapors, and organic compounds containing heavy metals (e.g.,

Primary Brain Cancer? (cont.)

events that sometimes happen inside a cell, without having an outside cause." American Cancer Society (2019).

There are a number of chemicals that can produce a *primary* cancer in the lung, liver or elsewhere. Sometimes, when such cancers become very advanced, they spread (metastasize) to other organs, including the brain. However, before the possibility of a *secondary* brain tumor resulting from chemical exposure can be entertained, there would have to be evidence of a *primary* cancer elsewhere. For example, Non-Hodgkins Lymphoma (NHL) can produce a *secondary* brain tumor.

The Swedish Q16

A questionnaire, known as the Swedish Q16, was developed to preliminarily screen long-term solvent-exposed workers. It seeks to distinguish between psychic vs. organic caused symptoms, and includes the following Yes or No questions:

- Do you have a short memory?
- Have your relatives told you that you have a short memory?
- Do you often make notes about what you must remember?
- Do you often have to go back and check things you have done such as turned off the stove, locked the door, etc?
- Do you generally find it hard to get the meaning from reading newspapers and books?
- Do you often have problems with concentrating?
- Do you often feel irritated

methyl mercury, tetraethyl lead, and organotin compounds) can produce symptoms within hours or days. In cases of heavy exposure, a permanent injury may result, but it rarely occurs. Most symptoms are resolved in a few weeks, once the exposure ends.

The ***chronic*** exposure to neurotoxins is a different matter. Most of the cells in your body are constantly being regenerated. For example, all the existing red blood cells in your body will be replaced within four months. However, the brain and central nervous system do not have the capacity to replace its cells, the way the rest of the body can. As a consequence, repeated exposures to chemicals that damage the brain can add up, and result in irreversible injury.

In cases of chronic exposure to solvents, diagnostic criteria for Chronic Toxic Encephalopathy were introduced by the World Health Organization (WHO) in 1985 and require *"verified exposure to neurotoxic solvents; clinical picture of organic nervous system damage with typical subjective symptoms and objective findings in clinical and auxiliary examinations and more common combinations of central and peripheral nervous system abnormalities; and other organic diseases and primary psychiatric diseases reasonably well excluded".*

In other words, you need to identify a chemical or agent that has been well-recognized as being capable of producing the symptoms, establish a period of chronic exposure, and exclude other possible causes. Establishing the diagnosis is much easier if others in the workplace have experienced similar symptoms.

Exposure is Everything

The first step in evaluating a potential toxic injury case is to obtain from the employer the Material Safety Data Sheets (now called Safety Data Sheets). Visit the **Practice Tips** section of our website for a guide to (Material) Safety Data Sheets.

A Safety Data Sheet (SDS) should exist for every chemical product used at the workplace. The SDS will identify the chemical ingredients in the product, and will include a description of the particular health hazards associated with each of them. In Section 11, "Toxicological Information", the SDS must include a description of the *delayed*, *immediate*, or *chronic* effects from short- and long-term exposure.

The Swedish Q16 (cont.)

without any particular reason?

- Do you often feel depressed without any particular reason?
- Are you abnormally tired?
- Are you less interested in sex that what you think is normal?
- Do you have palpitations of the heart even when you don't exert yourself?
- Do you sometimes feel pressure in your chest?
- Do you perspire without any particular reason?
- Do you have a headache at least once a week?
- Do you often have painful tingling in some parts of your body?
- Do you have any problems with buttoning and unbuttoning?

Note: Not all Yes answers support a toxin-related injury. If there are 6 or more Yes answers, the worker would be sent for a medical evaluation.

Exposure Pathways

The chemicals that *do* penetrate the Blood-Brain Barrier are carried there by the blood vessels that supply the brain. How do they get into the bloodstream?

Chemicals that exist as vapors, gases and aerosols are inhaled by the lungs. Most are then exhaled by the breathing process, but a portion may enter the small recesses of the lungs were the oxygen and carbon dioxide exchange takes place. Some chemicals are capable of entering the bloodstream along with the oxygen that is inhaled during normal respiration.

A second exposure pathway is dermal absorption. There are a number of solvents and other chemicals that can enter the bloodstream by coming into

For exposures that do not involve carcinogens, the amount of exposure, or dose, determines the effect. This is referred to as the ***dose-response relationship***, and it varies by chemical. Many chemicals have an initial range of exposures which can be experienced without producing symptoms - the No Observed Adverse Effect Level (NOAEL). The concept can be misleading in chronic exposure cases, because an exposure below the NOAEL may still result in a cumulative injury, if experienced hundreds of times over a number of years.

A woman who has her nails painted once a week, may have a small amount of exposure to Toluene (i.e., inhaling a low concentration for a short period of time) - a chemical that is capable of causing neurological damage. However, she is unlikely to ever experience any adverse effects, because her body can easily metabolize the chemical in such low doses.

A woman who works in the nail shop, painting the nails on 15 customers a day, may have 75 times the weekly exposure to Toluene as any single customer. And, a woman who works in the factory where the nail products are produced or bottled, may have daily exposures to Toluene that are a thousand times higher than those experienced by any nail salon worker, *if* she is not provided with adequate safety equipment and *if* adequate engineering controls are not in place to minimize exposure.

At what point is a single acute exposure, or a cumulative occupational exposure, capable of producing injury? It depends on the chemical and the dose.

Every exposure to a chemical results in a specific amount or ***dose*** that enters the body. The ***total dose***, refers to (1) the amount of the chemical that entered the body during a given exposure (either through inhalation, by ingestion, or by skin absorption), multiplied by (2) the number of exposures per day (i.e., the frequency of exposure), multiplied by (3) the number of days the exposure scenario was repeated (i.e., the duration).

Occupational Exposure Limits

OSHA has established *Permissible Exposure Limits* (PELs) for the many different chemicals that are used in the workplace. The limits may be expressed as a daily exposure limit (referred to as an *8-hour Time-Weighted Average*, or TWA), a ceiling limit and a peak

contact with exposed skin. Small molecule chemicals that can dissolve fat (i.e., *lipid-soluble*), are the ones that can most easily penetrate the protective layers of the skin, enter the bloodstream, *and* pass through the Blood-Brain Barrier. The longer the skin remains in contact with such chemicals, the greater the exposure (i.e., the *dose*).

Sometimes, *liquid* hazardous products also contain a *surfactant* - a class of chemicals that can facilitate skin absorption of the toxic component. So, the *reported* rate of absorption of the toxic chemical may not accurately reflect its true rate, if a surfactant is also present.

The third exposure pathway is ingestion. Ordinarily, this is not a typical pathway seen in occupational settings.

Biological Exposure Index (BEI)

A *recent* exposure to certain chemicals can be detected by testing the blood or urine for either the chemical, or a *metabolite* (i.e., a compound produced by the body in response to the chemical exposure). The **American Conference of Governmental Industrial Hygienists** (ACGIH) is a professional society that publishes reference values, known as Biological Exposure Indices (BEIs), for those hazardous chemicals that are susceptible to such detection. The utility of the BEIs (e.g., *"35 micrograms of inorganic mercury per liter of blood"*) is usually limited to the monitoring of workers who are *currently* employed in a contaminated environment, or to workers who have had a *recent* acute exposure.

Some toxic agents will accumulate in the body and can be detected years after exposure, but most are metabolized by the body over time and expelled. The harm they produce may persist, but the chemicals themselves are no longer detectable.

exposure limit, or *Short Term Exposure Limit* (STEL). For example, in California, a worker cannot be exposed to an environment that contains Toluene vapors at concentrations that *average* above 10 parts per million (ppm) over an 8-hour day. A brief 10 minute exposure, followed by 7 hours and 50 minutes of fresh air, may produce an 8-hour time-weighted average that is below 10 ppm, but that brief exposure cannot exceed 500 ppm (the Ceiling limit).

For a list of Cal/OSHA exposure limits, see their Table AC-1, at https://www.dir.ca.gov/title8/5155table_ac1.html.

Who is at the Greatest Risk?

Workers engaged in the production of paints, glues, coatings, degreasing agents, dyes, polymers, pharmaceuticals and printing inks are at the greatest risk of exposure to organic solvents.

Workers involved in making plastics, food packages, plastic pipes, pesticides, paints, wood preservatives, and rodent (rats and mice) repellants may be exposed to toxic Tin chemicals, such as *trimethyltin* and *butyltin*.

Welders working with carbon steel have exposure to Manganese vapors which can cause Parkinson's Disease-like symptoms.

Conclusion

If you need help understanding or evaluating a chemical exposure history, or help with any other aspect of a toxic injury case that you are handling, please contact us at *heubecklawpc@gmail.com*, as soon as possible.

Knowledge and Experience

John C. Heubeck, Esq. has prosecuted hundreds of toxic injury cases over the last 30 plus years, involving exposures to asbestos, benzene, chromium, hydrogen sulfide, talc and numerous other substances. A degree in Chemistry and employment as an Assistant Attorney General prosecuting OSHA violations have provided him with a unique and proven ability to litigate such cases through trial and before the appellate courts. Most plaintiff lawyers - *and defense lawyers* - lack a similar technical background and are usually at a clear disadvantage when handling such cases.

HEUBECK LAW, P.C.
Toxic Injury & Defective Products Litigation