

What dioxin does to our immune system?

By Peter Montague

The immune system is a complex set of specialized cells and organs that defends the body against attack. When it functions properly, the immune system fights off diseases caused by bacteria, viruses, fungi, parasites and cancer cells. "When it malfunctions, however, it can unleash a torrent of diseases, from allergy to arthritis to cancer to AIDS", according to the US National Institutes of Health (NIH).

At the heart of the immune system is the ability to distinguish between self and non-self. A healthy immune system protects the "self" and attacks only the "non-self". Virtually every cell in your body carries distinctive molecules that identify it as self. Cells lacking a "self" marker are quickly perceived as "foreign", attacked and eliminated by the immune system.

The immune system can fail in two ways: if it is damaged, it can fail to attack foreign invaders, and can thus allow infections or cancers to develop. On the other hand, if the immune system fails to distinguish self from non-self, it can overreact and attack the self, causing "autoimmune" diseases such as arthritis, asthma, lupus and Type I diabetes (insulin-dependent diabetes mellitus).

The US Environmental Protection Agency's (EPA's) 1994 draft reassessment of dioxin emphasized that dioxin damages the immune system directly and indirectly. From studies of rats, mice, guinea pigs, rabbits, cattle, marmosets, monkeys and humans, EPA concludes that even low doses of dioxin attack the immune system.

Dioxin directly reduces the number of B cells (immune cells that develop in the bone marrow, then circulate throughout the blood and lymph, fighting off invaders). And it reduces the number of T cells (immune cells that develop in the thymus), but dioxin's attack on T cells seems to be indirect.

EPA goes on to say, "... if an acute exposure to TCDD [dioxin] even temporarily raises the TCDD body burden at the time when an immune response is initiated, there may be a risk of adverse impacts even though the total body burden may indicate a relatively low average TCDD level". In other words, a single dose of dioxin at the wrong time may damage your immune system's ability to protect you.

Furthermore, dioxin can prevent the immune system from developing properly in an unborn child, with lifelong consequences, EPA believes. "Animal studies suggest that some immunotoxic responses may be evoked at very low levels of dioxin exposure", EPA says.

Multiple effects

Linda Birnbaum, director of research at the US EPA Health Effects Laboratory in Research Triangle Park, North Carolina, was the leader of an EPA scientific team reassessing dioxin. She says, "Dioxin appears to be a carcinogen in fish, rodents and other mammals, including humans. But dioxin can also modulate [modify] the immune system, resulting in an inability to fight disease. It is a very

powerful immunosuppressant. But it can also upregulate [excite] the immune system so that you start becoming hypersensitive, developing autoimmunity and allergies."

Birnbaum goes on to describe Taiwanese children, exposed to dioxin-like chemicals, who had unusually frequent respiratory infections and ear infections. Further, she described an Inuit population in Quebec with elevated levels of dioxin in their bodies from eating the fat of marine mammals (seals); their children have "very high incidences of respiratory infections and otitis [ear infections], and also a very decreased take of vaccinations", Birnbaum says. Vaccinations don't work well in these children, perhaps because their immune systems have been damaged.

Birnbaum says there is no threshold for immunotoxic responses to dioxin; in other words, there is no level of dioxin below which the immune system is not affected. Any amount of dioxin seems to do some damage to the immune system, at least in animals; there is no "safe" dose.

In laboratory mice, a single tiny dose of dioxin causes increased deaths when the mice are challenged with an influenza virus. It is worth emphasizing that the effective dose of dioxin is very small: 10 nanograms of dioxin per kilogram of body weight harms the mouse immune system enough to increase the death rate from influenza virus.

To get 10 ng/kg into perspective, consider that a single 5-grain aspirin tablet taken by a 70-kg adult is a dose of 4.7 million nanograms of aspirin per kilogram of body weight. For an adult human to get a dose of aspirin equivalent to the dose of dioxin that harms the mouse immune system, you would have to divide a single aspirin tablet into 470,000 pieces and eat only one piece. Is the human immune system as sensitive to dioxin as the mouse's? No-one yet knows.

What about animals more human-like than mice? Tom Webster of the Boston University School of Public Health cites evidence that the number of immune cells in rhesus monkeys is changed by a dioxin body burden of 270 ng/kg; in marmosets, the number of immune cells is changed at only 6 to 8 ng/kg of dioxin. "While the medical implications of this effect are unknown, it appears to occur at about the average human body burden of dioxin-like compounds", he says. In other words, average residents of North America carry 7 to 9 ng/kg in their bodies now, and 6 to 8 ng/kg alters the immune systems of marmosets.

"Similar effects [immune cell alterations] were seen in the children of mothers who lived in dioxin-contaminated Times Beach, Missouri, during and after pregnancy", Webster notes, citing work by Gerson Smoger and others.

This past [northern] summer, German researchers published a study of the health of 158 chemical workers who had been exposed to dioxin in 1953 during an industrial accident at a BASF chemical plant. The 158 exposed workers were compared to 161 unexposed workers.

The dioxin-exposed workers experienced more frequent infections and parasitic diseases during the 36 years after exposure, consistent with immune system damage. Especially noticeable were increases in respiratory infections, thyroid diseases, disorders of the peripheral nervous system and appendicitis. Mental disorders were also increased. All together, the highly exposed group had 18% more recorded episodes of illness than the control group.

Unpleasant surprises

Ironically, the largest source of dioxin entering the environment today is medical incinerators. Together, medical incinerators and municipal solid waste incinerators account for 95% of all dioxin emissions into the air of the US, according to EPA.

The good news is: these technologies are not needed and could be phased out rapidly, if public health authorities began to take their disease prevention responsibilities seriously. For both medical wastes and municipal wastes, alternatives already exist that are cleaner, safer, and less expensive.

Unfortunately, instead of planning to phase out incinerators, EPA has announced plans to "regulate" incinerator emissions more tightly by requiring air pollution scrubbers. Scrubbers will not decrease dioxin production, but will move dioxin from the air emissions into the incinerator ash, which gets buried in shallow pits in the ground. Thus, current public health policies are creating a legacy of unpleasant surprises for our children. [From Rachel's Environment & Health Weekly (US).]

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