



Parkinson Disease and the Environment

What is Parkinson Disease?

Named after Dr. James Parkinson, who first described the symptoms of "shaking palsy" in 1817, the cause of Parkinson disease (PD) remains unknown. Until recently, PD has been described as a chronic, progressive neurological disease that affects a part of the brain that produces dopamine, a chemical that tells muscles how to move. Generally, by the time the disease is diagnosed, up to 80 percent of the dopamine-producing neurons are no longer functioning.

In the past decade, more and more researchers and physicians are coming to see it as "a multisystem disorder in which predisposed neuronal types in specific regions of the human peripheral, enteric, and central nervous systems become progressively involved" (Braak, et al.). However, nearly all of the available research has focused on the dopamine system, so that will be covered here.

Loss of neurons in the substantia nigra (where dopamine is produced) leads to a variety of symptoms such as:

- Tremors (shaking) *
- Slowness of movement ("bradykinesia") *
- Loss of facial expression – also called "masking"
- Softer voice and/or slurred speech
- Changes in decision-making, memory, judgment and other mental abilities
- Muscle rigidity (stiffness) *
- Poor balance ("postural instability") *
- Loss of sense of smell
- Small, cramped handwriting
- Sleep disorders

** These are the four hallmark signs that doctors look for to diagnose Parkinson disease. Not all people with Parkinson's experience all these signs, especially early in the disease. Another determinant of a PD diagnosis – clumps of protein called Lewy bodies found in the brain – cannot be assessed until after death.*

Parkinson disease (PD) affects 500,000 to 1.5 million Americans. Alzheimer's disease is the only progressive neurodegenerative disease that affects more people. There are no good statistics on the number of cases because the difficulty of diagnosing the disease in its early stages, the lack of lab tests to confirm the diagnosis, and the absence of a national registry or tracking system.

Who gets Parkinson disease?

Parkinson disease affects people of all races, geographic areas and socioeconomic levels. Rates are higher in men than women. The average age of diagnosis is 60, but 15 percent of patients are under age 50 (Lieberman and McCall). Aging increases the risk of developing PD (Bronstein, et al.).

What causes the primary symptoms of Parkinson disease?

Historically, research has focused on a part of the brain called the substantia nigra, which is responsible for producing dopamine. Dopamine is one of the neurotransmitters (chemical messengers) that controls muscle movement. As stated earlier, another theory posits that the neurons in multiple areas of the brain that make dopamine or other neurotransmitters are damaged or die.

What causes the degeneration or death of dopamine-producing neurons?

No one knows for certain what causes these brain cells to degenerate or die in a large majority of cases, but there are a number of hypotheses.

One theory is that molecules called free radicals damage neurons in a process called oxidation. Free radicals are missing electrons and "steal" them from other molecules. When the body is functioning properly, molecules called antioxidants intercept and neutralize free radicals before they can cause damage. The brain of a person with Parkinson disease may have more free radicals, fewer antioxidants or both.

Others think that premature aging makes the neurons die long before they normally would. This may be genetic or may be caused by a chemical or a pathogen (germ). Inflammation of these neurons early in life may change their "programming," triggering premature death. Some chemical contaminants are known to kill neurons outright.

A protein called alpha-synuclein may be involved in the development of Parkinson. Researchers have found clumps of this protein in the autopsied brains of PD patients. At this time, the exact role alpha-synuclein may play in causing the disease is unknown.

What are some of the risk factors that might increase the chance of developing PD?

Researchers who participated in the Consensus Conference on Parkinson's Disease and the Environment in June 2007 were confident that there is sufficient evidence that the following potential risk factors are associated with developing Parkinson disease (Bronstein, et al.).

- Having had a severe head injury
- Being exposed to pesticides
- Being a non-smoker
- Being a non-coffee drinker
- Being a farmer, rancher or agricultural worker
- Consuming a lot of dairy products (men only)

Studies of twins suggest that Parkinson disease is not inherited. However, with a younger age of onset, genetic factors appear to be important. Several genes have been identified that appear to have a role in the onset of certain cases of PD. However, all of the cases of PD linked to genetic mutations are estimated to be less than 10 percent (Bronstein, et al.). In some families, PD is present in more than one generation and research is attempting to define the role of genetics and the shared environmental exposure that may explain the clustering of disease.

Many neurologists tell their patients "genetics loads the gun, but the environment pulls the trigger." Environmental factors are often suggested as possible causes of PD. In this case, the term "environment" really refers to the entire world outside of the body and thus includes several sources, such as pathogens (e.g., viruses, bacteria), toxic chemicals and heavy metals.

The standard against which other chemicals are evaluated when assessing causal links to Parkinson is MPTP. In the 1980s, some San Francisco drug users mistakenly took MPTP—a compound chemically similar to the pesticide paraquat—instead of heroin. Within weeks or months, many of them developed irreversible Parkinson-like symptoms. The chemical has a consistently similar effect in lab animals.

That trigger could be something other than toxic chemicals, but there is ample evidence to implicate a role for chemicals in the body fostering conditions that destroy essential neurons.

Some chemicals seem to be directly toxic to neurons. Others may create inflammation in the brain, which reduces the body's resistance to toxins. Another theory is that toxins affect gene expression, meaning that the chemical changes the instructions that the gene gives a particular cell about cell processes, such as cell death (Myers).

Inflammation from external events such as a severe head injury ("traumatic brain injury") or a viral infection early in life is another risk factor for Parkinson. Inflammation from such incidents could affect the brain's ability to respond to other insults as the individual gets older.

In the case of a viral infection at an early age, the number or the quality of dopamine-producing neurons might be affected, making any reduction later in life much more noticeable. Tracking exposure to viruses is also difficult; people may not recall what childhood illnesses they experienced or may not have even been aware that they were sick, especially if illness occurred when they were young. Also, new studies indicate there may be a connection between chronic inflammation caused by allergies and the later development of PD (Bower, et al.; Lister).

A number of pesticide products have been strongly linked to PD in animal studies, such as:

- Rotenone, a commonly used plant-based pesticide that is believed to cause both inflammation of the brain, which leads to death of dopamine-producing neurons (Liu, et al.). This compound is often used to kill fish that are considered undesirable or a threat to recreational or commercial fisheries.
- Paraquat, an insecticide, is chemically similar to MPTP, a compound that induced Parkinson-like symptoms in some individuals who had been attempting to synthesize heroin but made MPTP instead. MPTP is used as a prototype against which the toxicity of other chemicals is measured. Paraquat is applied to a number of food crops, including corn and soybeans – both commonly grown in the Midwest – as well as cotton and fruit. Maneb is used on corn and other vegetables, such as potatoes, lettuce and tomatoes. (Barlow, et al.)
- Some fungicides – maneb, for example -- contain manganese, a heavy metal that has long been associated with Parkinson-like symptoms (Zhou, et al.).

When laboratory mice are exposed to paraquat and maneb at the same time, many of them develop nearly all of the physical signs of PD seen in humans. Corn is one crop that frequently receives application of both products.

Organophosphate pesticides such as chlorpyrifos (Dursban™) and organochlorine compounds such as lindane – a highly toxic pesticide still used in the U.S. to treat head lice – and polychlorinated biphenyls (PCBs) may also have lethal effects on dopamine-producing neurons (Carpenter, et al.).

There is limited evidence that some heavy metals (aluminum, iron, lead and manganese) may be associated with PD. Autopsies on the brains of PD patients have found elevated levels of aluminum and iron. Because of the known neurotoxicity of manganese, many people have expressed concern about the potential health risks of the manganese-based gasoline additive MMT (Dobson, et al.). Welding fumes contain many metals, including manganese, and some studies indicate that exposure to welding fumes may cause Parkinson-like symptoms. The condition is not considered to be the same as PD (Cersosimo and Koller; Park, et al.).

How could I be exposed to these risk factors?

Firsthand exposure to some of these risk factors is a matter of individual choice. Clearly, even though some component of coffee and of cigarette smoke appears to play a role in *reducing* a person's risk of developing PD, CHE is not recommending that any person begin smoking or drinking coffee. There are other reasons why choosing to expose yourself to those products may be unhealthy for you.

We have only partial control over our exposure to some risk factors. Germs travel from person to person quite readily, in many cases. Food, groundwater and surface water may all contain pesticide residues. Airborne pollen may be another source of exposure. Your occupation or workplace may place you in contact with some of these contaminants.

Some parts of the country have high levels of heavy metals that are naturally occurring in their water supply. Fertilizer products that contain hazardous industrial waste are another potential source of heavy metals in the environment. Sewage sludge, which is land-applied to farmland as a fertilizer in many parts of the country, can contain pesticide residues and other chemicals, heavy metals and pathogens.

What can I do to minimize my exposure to environmental contaminants for overall better health?

- Know where contamination sources are. Find out what chemicals are in the products you use every day at home, school and work. Learn where community sources of pollution might be, such as hazardous waste sites, incinerators, etc.
- Buy organic food whenever possible. Shop at farmers markets or purchase produce, meats and dairy products from local vendors when you can – ask them about the methods they use to grow their crops or raise their livestock.
- Minimize your exposure to pesticides and heavy metals by using organic gardening methods in your yard and garden. Use non-toxic or least-toxic pest control methods to deal with insects or other pests in and around your home.
- Use non-toxic cleaning products around your home and workplace.

If I am concerned about the links between pollution in the environment and chronic diseases, such as Parkinson disease, what can I do?

You can join the CHE Working Group on Parkinson Disease and the Environment. To learn more about the working group, visit www.healthandenvironment.org/working_groups/parkinsons/.

Become a CHE partner today! It is free and there is no obligation to participate, although we hope that you will discuss your concerns about environmental links to disease with your family, friends, neighbors, co-workers and policymakers.

The **Collaborative on Health and the Environment (CHE)** is a nonpartisan partnership of individuals and organizations that seeks to raise the level of scientific and public dialogue about the role of environmental factors in many of the common disease, disorders and conditions of our time.

Established in 2002, CHE welcomes participation from health professionals, researchers, health-affected and patient groups, and indeed anyone concerned about protecting the health of current and future generations from environmental harm.

You can learn more about CHE by visiting our website, **www.HealthandEnvironment.org**, or by contacting us at info@healthandenvironment.org.

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