

## Parkinson's, Pesticides and other Environmental Causes

### What is Parkinson's Disease?

Parkinson's disease (PD) is 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.

Loss of dopamine 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
- Muscle rigidity (stiffness)\*
- Poor balance (postural instability)\*
- Loss of sense of smell
- Small, cramped handwriting

*\* These are the four hallmark signs that doctors look for to diagnose Parkinson's disease. Not all people with Parkinson's experience all these signs, especially early in the disease.*

Named after Dr. James Parkinson, who first described symptoms of "shaking palsy" in 1817, the cause of PD remains unknown. Parkinson's disease affects 500,000 to 1.5 million Americans—more than the combined numbers of people with amyotrophic lateral sclerosis (ALS), muscular dystrophy, multiple sclerosis and myasthenia gravis. Alzheimer's disease is the only neurological disease that affects more people. There are not good statistics on the number of cases because of the difficulty of diagnosis 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's disease?

Parkinson's disease affects people of all races, geographic areas and socioeconomic levels. Rates are higher in men than women, although studies dispute by how much. The average age of diagnosis is 60. Eighty percent of people with PD are diagnosed between the ages of 40 and 70, but five percent are diagnosed between 30 and 40 years old.<sup>1</sup>

### What causes the primary symptoms of Parkinson's disease?

A part of the brain called the substantia nigra is responsible for producing dopamine. Dopamine is one of the neurotransmitters (chemical messengers) that controls muscle movement. In PD, the brain cells (neurons) that make dopamine 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 theories.

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 PD 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's. 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 have identified a number of risk factors for developing PD, including:

- Having had a head injury
- Living in a rural area
- Being a farmer, rancher, fisher or welder
- Being exposed to a high level of carbon monoxide
- Having a history of depression
- Drinking well water
- Being frequently exposed to solvents

Studies of twins suggest PD is not inherited. However, with a younger age of onset, genetic factors appear to be important. Thus far, six genes have been identified that appear to have a role in the onset of certain cases of PD. 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” refers to the entire world around the individual and pathogens (e.g., viruses, bacteria), toxic chemicals and heavy metals. The trigger could be something other than toxic chemicals, but ample evidence implicate a role for chemicals in the body fostering conditions that destroy dopaminergic neurons.

The standard against which other chemicals are evaluated when assessing causal links to Parkinson’s is MPTP (1-methyl 4-phenyl 1,2,3,6-tetrahydropyridine). 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.

Some chemicals appear 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.<sup>2</sup>

A number of pesticides have been strongly linked to PD in animal studies, including:

- ◆ Rotenone, a commonly used plant-based pesticide that is believed to cause inflammation of the brain, which leads to death of dopamine-producing neurons.<sup>4</sup> 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, a fungicide often used with paraquat, is used on corn and other vegetables, such as potatoes, lettuce and tomatoes.<sup>5</sup>
- ◆ Some fungicides—maneb, for example—contain manganese, a heavy metal that has long been associated with Parkinson-like symptoms.<sup>6</sup>

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™), 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.<sup>7</sup>

Several heavy metals have been implicated as possible contributors to PD, including aluminum, iron, lead and manganese. 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.<sup>8</sup> Welding fumes contain many metals, including manganese, and some studies indicate that exposure to welding fumes may cause Parkinson-like symptoms.<sup>9,10</sup>

The first chemical linked to Parkinson symptoms in humans was carbon monoxide (CO). Even a single acute exposure to a high level of CO may cause PD symptoms to develop within hours to days, accompanied by brain damage characteristic of CO exposure.<sup>11</sup> Some cases are irreversible,<sup>12</sup> while others resolve spontaneously.<sup>13</sup>

Like some heavy metals, CO is actually necessary in minute amounts. It is produced by the body when breaking down iron in the blood—a process essential to normal body function. CO can also be a pollutant in the environment. Either way, researchers have discovered that people with PD have elevated levels of the enzyme that produces CO, and decreased oxygen levels in the parts of the brain associated with PD, namely the substantia nigra and the basal ganglia.<sup>14</sup> High levels of CO in the brain have been shown to cause inflammation in the brain and may be involved in the formation of Lewy bodies—clumps of protein in the brain that are considered to be hallmarks of PD.<sup>15</sup>

Contracting a viral infection early in life is another risk factor for Parkinson's. Inflammation from such infections could affect the brain's ability to respond to other exposures as the individual gets older. Or it could be that the early viral infection affected the number or the quality of dopamine-producing neurons, 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.<sup>3</sup>

#### **How could I be exposed to these risk factors?**

Exposure to these risk factors occurs in a number of ways. Germs travel from person to person quite readily. Food, groundwater and surface water may all contain pesticide residues. Airborne pollen may be another source of exposure.

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.

Your occupation or workplace may place you in contact with some of these contaminants. As stated earlier, some studies indicate that being a welder or farmer increases your risk of developing PD.

## How can I minimize exposure to environmental contaminants for overall better health?

- Know where contamination sources are. Find out what chemicals are in everyday products used at home, school and work. Also learn about your community sources of pollution, 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 crops or raise 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.
- Minimize your exposure to carbon monoxide. Install at least one digital CO detector. Make sure that gas appliances, such as water heaters, dryers, furnaces and stoves, are properly vented and have them checked regularly for CO. Never leave vehicles idling in attached garages, and never use gas generators indoors.

*This factsheet was begun when the author, Jackie Hunt Christensen, was co-director of the Food and Health Program at the Institute for Agriculture and Trade Policy (IATP). IATP is a founding member of the Collaborative on Health and the Environment (CHE). This factsheet first appeared on the CHE website: [www.healthandenvironment.org](http://www.healthandenvironment.org). We are pleased to reproduce it in conjunction with CHE.*

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