



# Pesticides and Human Health

**T**he National Research Council and Academy of Science in the U.S. was commissioned to study scientific and policy issues concerning pesticides in the diets of infants and children. They have concluded the following:

- The amounts and variety of pesticides now used are far greater than in any other time in history.
- Both quantitative and qualitative differences in toxicity of pesticides exist between children and adults. Infants and children may develop toxic outcomes from smaller quantities due to different metabolic rates, greater absorptive areas, diets more concentrated with certain foods high in pesticides but they may also have outcomes such as neurological, behavioural, endocrinological and oncological that are not seen in adults due to critical windows of exposure both in utero and during certain growth phases.
- 'Tolerances' constitute the most important mechanism by which maximal allowable levels of pesticide residues in food are determined. Tolerance

concentrations are based primarily on the results of trials conducted by pesticide manufacturers and are designed to reflect the highest residue concentrations likely under normal conditions of agricultural use. Tolerances are not based primarily on health considerations.<sup>1</sup> Medical clinicians and researchers need to ensure that maximal allowable levels are based on health considerations – both in the level found on food sources and in that consequently found in water and soil.

- Current regulatory systems look only at the average exposure of the entire population. As a consequence, variations in dietary exposure to pesticides and health risks related to age and to other factors such as geographic region and ethnicity are not addressed.<sup>1</sup>
- Diet is an important source of exposure to pesticides.<sup>1</sup>



## How is the issue of PESTICIDES relevant to CANADIAN PHYSICIANS and their PATIENT POPULATION?

**Q** Is the chronic exposure from food and water, surface contact from lawn spraying, play structures and homes causing long term effects such as birth defects, neurotoxicity or increases in behavioural, endocrine, immunological and oncological disease?

**A** The Committee on Pesticides in the Diet of Infants and Children (CPDIC) concluded that the population is at great risk from the existing allowable levels of pesticide residues and that the data strongly suggest that exposure to these neurotoxic compounds at levels believed to be safe for adults could result in permanent loss of brain function when it occurs during prenatal and early childhood periods of brain development.<sup>1</sup>

Toxicologists agree that by extrapolation from hazard assessment studies conducted primarily in rodents, pesticides have the potential to produce toxicity in humans, a potential that includes many different toxic end points. Recent studies have investigated nonoccupational human exposure, such as those presented by Leiss et al, who demonstrated an association between yard treatments and soft tissue sarcomas (odds ratio 4.0) and the use of pest strips and leukemias (OR 1.7–3.0) in children.<sup>2</sup> Similar findings have been reported by Gold et al, who

report an association between exposure to insecticide extermination and brain tumors (OR 2.3)<sup>3</sup>; Lowengart et al, who report an association between household pesticides and leukemia (OR 4.0) and garden pesticides and leukemia (OR 5.6)<sup>4</sup> and most recently Davis et al, who found odds ratios up to 6.2 for several pesticide specific exposures among children with brain cancer.<sup>5</sup>

**Q** Are we as a medical community ensuring that pesticides, as a public health issue, are being adequately monitored and controlled to ensure appropriate protection of the population?

**A** The CPDIC<sup>1</sup> has demonstrated that infants and children are particularly at risk of consuming toxic amounts of pesticides. This data is transferable to our Canadian population and we need to ensure that our public health system includes methods of determining maximal allowable levels of pesticides in foods based on human health outcomes, that there is education and restrictions on home and institutional pesticide spraying where children and adults can be exposed to acute and chronically toxic levels of pesticides and support the use and development of nontoxic alternatives. ♦

# EXPOSURE TO PESTICIDES

## EXPOSURE OCCURS THROUGH INGESTION OF FOOD AND WATER AS WELL AS SKIN AND RESPIRATORY ABSORPTION

### WHY ARE PESTICIDES OF GREAT CONCERN IN THEIR EFFECT ON HUMAN HEALTH?

*The most widely used pesticides function by disrupting neurological cellular function. The systemic toxic effects after acute exposure are well documented and the CPDIC conclude that emerging data suggest that neurotoxic and behavioural effects may result from low level chronic exposure to organophosphates and carbamate pesticides.<sup>1</sup> These are commonly used pesticides in Canada; found in food, lawn and garden pesticides and household products.*

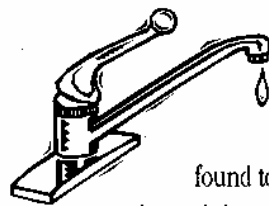


### FOOD

• Although many pesticides act at the same site no calculations are made to determine multiple residual exposure in diets.

Many food products will have a number of pesticide residues. Agriculture Canada reports that the average peach in Canada has 31 pesticide residues.<sup>6</sup> The majority of these act at the same sites; the parasympathetic and central nervous systems. Although the residue of one pesticide may not exceed the maximum allowable level, a number of pesticides of the same class, acting at the same physiological sites, will have a cumulative and possibly toxic effect.

### WATER



• Pesticides are commonly found in water consumed by both rural and urban populations.

Groundwater was found to have residues of 39 pesticides and their degradation products in a study of U.S. states and Canadian provinces.<sup>7</sup>

weight is double that of the adult, infants have much greater unprotected skin contact with such surfaces and tend to mouth objects that may be exposed to these surfaces. It must also be realized that adults also are absorbing pesticide residues from such sources contributing to chronic exposure.

• Insect repellents and pediculocides are concentrated exposures that are absorbed through the intact skin. There are reports of children developing behavioural changes, encephalopathy, ataxia, seizures and coma following cutaneous exposure<sup>8</sup> and neurobehavioural correlations have been found between cutaneous exposure and affective symptoms, insomnia, muscle cramps and urinary hesitation.<sup>9</sup>

• Farmers exposed to herbicides, through spraying and predominantly skin absorption, for more than 20 days per year have been found to have a sixfold increase of non-Hodgkins lymphoma.<sup>10</sup>

• Pesticides are airborne thus they are found long distances from the site of application. Restricting the use of organochlorines (DDT, etc.) in Canada does not result in eliminating human exposure, as air, and then water and food contamination are not obstructed by borders. ♦

• Allowable pesticide levels for water are calculated on the basis of adult exposure and toxicity but again the pediatric population is exposed to a considerably greater total amount of residues that are potentially toxic because they are consuming on average 4 times the amount of water per kg of body weight.<sup>1</sup>

• Residues of pesticides that are "severely restricted" because of their serious effects on human health were also found in significant quantities in the water sources.<sup>1</sup>

• Residues enter the water supply as they are leached from soil into ground water after home, lawn, roadway and agricultural spraying.

### RESPIRATORY AND SKIN ABSORPTION

• Infants and children can absorb enough pesticide through their skin to produce toxicity. There are a number of reports of infants and children presenting with poisoning secondary to playing on lawns and surfaces that have had pesticides applied.<sup>7</sup> The surface area of infants per unit body



### KWELLADA

*Prescribed commonly by physicians in Canada for treatment of head lice and scabies, this is a brand name for Lindane, an organochlorine. The organochlorines have been banned as agricultural pesticides because of their SEVERE NEUROTOXICITY and PERSISTENCE in the environment. There is ongoing concern regarding their medical use as they are potent neurotoxins being used on the head and because they have been shown to have an increased cumulative mortality in animals.<sup>11</sup> Physicians should be using readily available alternatives that are not organochlorines.*

# WHAT ARE THE ASSOCIATED TOXICITIES OF THE MOST COMMONLY USED PESTICIDES?

## 1 ORGANOPHOSPHATES & CARBAMATES: Diazanon, Dursban, Basudin, Sevin

Both organophosphates and carbamates bind cholinesterases and block their action in the hydrolysis of the acetylcholine neurotransmitters, thus acting principally in the parasympathetic and central nervous system. These have now become the most widely used agricultural pesticides.

- Infants under 6 months appear to be particularly susceptible because they have incompletely developed acetylcholinesterase systems and their immature livers are unable to detoxify these compounds.<sup>1</sup>
- It appears that not only is this age group more susceptible to toxicity due to physiological difference but their activity and diets also put them at increased risk. Zwiener and Ginsberg<sup>12</sup> investigated 37 children exhibiting moderate to severe organophosphate and carbamate toxicity. Although the majority were the result of accidental ingestion *17% of the patients developed signs and symptoms of moderate to severe pesticide toxicity after playing on sprayed surfaces.*
- Visual system damage is linked to dietary exposure to some cholinesterase inhibitory compounds.<sup>1</sup>
- Neurotoxicity depends on the stage of brain development of those exposed. As different human brain structures have varying peak periods of growth it is felt that, like lead toxicity, prenatal and early childhood exposure is particularly toxic.<sup>1</sup>
- Sherman (1995) describes 4 children with an unusual pattern of birth defects including defects neurological and genitalia. Exposures had occurred in utero to Dursban an organophosphate pesticide. A review of the literature shows similar defects in test animals and other children exposed to organophosphates.<sup>13</sup>

## 3 ORGANOCHLORINES:

These pesticides are chlorine containing compounds including DDT, aldrin, dieldrin and lindane. The organochlorines act through disruption of neurotransmission. PCB's, which are not used as pesticides, are also organochlorines with similar human action and thus have the potential for an additive effect.

- The greatest concern with the organochlorines are the long term effects. The U.S. EPA has concluded that DDT, DDE and DDD are probable human carcinogens. On this basis both Canada and the U.S. banned the organochlorines however, they continue to be very prevalent posing long term health risks.
- The organochlorines are still widely used in developing countries including Central and South America, India, China and many other countries. Products imported from these countries are obvious sources of DDT and other organochlorines. They are also transported in air, oceans

## 2 CHLORPHENOXY HERBICIDES: Lawn & Weed Killers such as 2,4-D or Killex, Par 3



These are another very widely used group of pesticides in Canada and worldwide; most commonly used to kill dandelions and broad-leaved weeds in lawns, parks, golf courses and school yards.

- Concern over possible carcinogenic risks from these products is heightened by the potential for widespread exposure. In addition to herbicide formulations used on lawns and in agriculture, these chemicals occur in many wood, leather and textile stains and preservatives.
- The recent study on Home Pesticide Use and Childhood Cancer<sup>2</sup> demonstrated a significant correlation between yard treatment with pesticides and pediatric soft tissue sarcoma and between pesticide strips and pediatric leukemias. The pesticide used in pest strips has been shown to be a carcinogen in animals and this strong association with leukemia in children is disturbing given their common use and accessibility to infants and children. This occurs directly or indirectly following application on lawns, lawn furniture and play structures and through storage in the home.
- There are many studies linking exposure to these herbicides with cancer. Studies from Sweden have suggested that workers exposed are at an increased risk of developing soft-tissue sarcoma, Hodgkin's disease and non-Hodgkin's lymphoma. Hoar et al<sup>14</sup> found that exposure to herbicides on greater than 20 days per year resulted in a 6 fold increase in non-Hodgkin's lymphoma. These findings coincide with the findings of increased incidence of NHL in caretakers of golf courses and previous studies on farmers.

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**ORGANOCHLORINES** (continued from page 3)

and bioaccumulate in organisms.<sup>15</sup>

- Food is the primary route of exposure. Foods which may contain DDT include: meat, fish and poultry, dairy products and root and leafy vegetables. Fish from the Great Lakes Basin and inland waters are a large food source of organochlorine exposure.
- A study of the concentrations and dietary intake of selected organochlorines in fresh food composites grown in Ontario demonstrated that organochlorine residues were detected in all of the food composites. This included all types of fresh food grown in Ontario including beef, poultry, fruits and vegetables (it did not include fish). The findings suggest that consumption of eggs and meat is also a significant source of exposure to the majority of organochlorine chemicals studied.<sup>16</sup>
- The provincial and federal health departments report that there are instances where maximum allowable levels of DDT intake may be exceeded in breast-fed infants.<sup>16</sup>
- Similarly, they report that people living near hazardous waste sites have been found to have an increased exposure to organochlorines in large part because of leaching into the soil.<sup>16</sup>
- In fish and wildlife, there is evidence of reproductive and developmental effects as a consequence of chronic exposure. There is increasing concern that exposure of humans to these chemicals may be causing adverse effects on reproductive function. A number of chemicals in the environment possess estrogenic activity and these compounds include pesticides as well as plasticizers, estrogenic agents administered to livestock and a variety of other chemicals.
- Dr. W. Foster, Head of the Reproductive Toxicology Section at Health Canada concludes, "on the topic of environmental exposures and human reproduction in women, that the consequences of exposure to environmental contaminants over the course of a lifetime are difficult to assess and the available literature does not support a clear conclusion that reproductive health of women has been adversely affected. Nevertheless, the absence of sound epidemiological data to support a causal association between various adverse reproductive outcomes and exposure to chemicals present in the environment cannot be viewed as evidence that such an association does not exist — it is possible that trace contaminant levels may exert clinically subtle effects on female reproductive function such as altered steroid hormone levels. There is a need for well designed studies that need to incorporate sensitive outcome measures such as time to pregnancy, spontaneous abortion rates and breast cancer as well as better defined means of determining body burdens of suspected reproductive toxins."<sup>17</sup> ♦

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**ACTIONS BY PHYSICIANS**

- Be aware of the possibility of acute or chronic toxicity secondary to both local lawn spraying, home application and food intake.
- Educate patients regarding the known health concerns associated with pesticides.
- Encourage alternatives to pesticides including
  - ♦ buying organic products
  - ♦ using alternatives to pesticides for lawn and garden care as well as indoor pest management. The Toronto Environmental Alliance (TEA) has a Green Thumb Project where volunteer homeowners trained in chemical-free lawn maintenance will educate any interested homeowner.
  - ♦ ensuring that local governments and business are not exposing patients or your community pesticides by local spraying or pesticide application. Cote St. Luc, a Montreal area town has passed a bylaw prohibiting general applications of pesticides. Patients should be encouraged to organize similar endeavours in their communities. ♦

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