

HUMAN HEALTH

Properties that allow pesticides to control pests can also pose a hazard to humans. Exposure to pesticides can be from inhalation, skin or eye contact, or ingestion. Poisoning symptoms can be mild, severe, or result in long-term health problems. Poisoning depends on the toxicity of the pesticide and the amount of exposure to it. Symptoms can appear after just one exposure or after repeated exposures to small doses of pesticide over time. Applicators must know how pesticides work, symptoms of poisoning, and routes of exposure. This will allow them to do what they must to reduce risk.

Before a pesticide can be registered for use in Canada under the *Pest Control Products Act*, research data to determine the pesticide's potential to cause harm to humans must be submitted to the Pest Management Regulatory Agency. This data is used to determine if the pesticide will be registered for use, the personal protective equipment needed and care required for safe handling and use.

This chapter looks at these issues and provides direction to reduce risk.

Learning Objectives

Completing this chapter will help you to:

- List the two types of toxicity.
- Describe the differences between acute and chronic toxicity.
- List the routes of entry into the body for pesticides.
- List ways to prevent entry of pesticides into the body.
- List the factors that affect exposure to pesticides.
- List ways to prevent exposure.
- List the symptoms of different levels of acute pesticide exposure.
- List the pesticide families that affect the human nervous system.

Risk

Risk is the chance that a pesticide may cause harm. When a pesticide is handled or applied, there is some human risk. The amount of risk depends on:

- The toxicity of the pesticide
- The amount of exposure to the pesticide.

$$\text{Risk} = \text{Toxicity} \times \text{Exposure}$$

From this equation, it follows that the greater the toxicity, the greater the risk. The type or concentration of active ingredient will affect pesticide toxicity. Some active ingredients are more toxic than others. Higher concentrations of an active ingredient also increase a pesticide's toxicity. A brief exposure to a very toxic pesticide might have the same effect as long-term exposure to a less toxic pesticide.

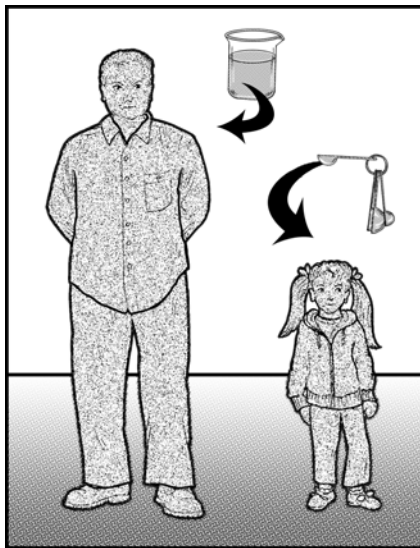
Proper attitude and care will reduce risk.

- Read labels.
- Always keep safety in mind.
- Follow pesticide use instructions.
- Choose less toxic pesticides.
- Wear proper personal protective equipment.

Risk can be reduced by wearing the personal protective equipment called for on the pesticide label.

Toxicity

Toxicity is the degree to which a pesticide can cause harm to an organism. Most chemicals, including pesticides, can be poisonous to humans if taken into the body in large amounts.



Sensitivity to a pesticide, or even an adjuvant, can vary among people. Such sensitivity can sometimes increase after a number of exposures. One person may show no reaction to an exposure that causes severe illness in another person. An individual's age and body size will also influence the response to a pesticide exposure. Infants and young children are normally affected more by milder exposures than are adults. Similarly, adult females are often affected by milder exposures than are adult males.

Figure 4-1: A child who is 1/5 the weight of an adult would require only 1/5 the amount of pesticide to suffer the same toxic effects as an adult.

Individuals may vary in sensitivity or reaction to the same level of pesticide exposure.

Acute and Chronic Toxicity

Toxicity can be either acute or chronic. Acute toxicity means the ability of a substance to cause ill effects which develop soon after exposure (i.e. a few hours to a few days). Acute toxic effects may develop, for example, if you splashed pesticide on yourself or if you were exposed to drift while spraying. Symptoms of acute toxicity may be relatively mild such as nausea, headaches, or stomach cramps, or as severe as convulsions, coma, or death. Acute toxic effects may be either reversible or irreversible, but usually they are reversible.

Chronic toxicity means the ability of a substance to cause ill effects which last a long time. Chronic toxic effects may not appear for some time after exposure.

They may last many years and are often irreversible. Acute toxicity effects are often reversible.

Acute toxicity is measured by LD₅₀ values. The LD₅₀, or Lethal Dose 50%, is the amount of a substance in one treatment which kills 50% of the animals (such as rats and mice) in a test. These treatments are given through the skin, (dermal) or through the mouth (oral). The LD₅₀ value is measured in mg of pesticide per kg of body weight of the test animal.

Toxicity can also be measured with an LC₅₀. The LC₅₀ (Lethal Concentration 50%) is the concentration (expressed in parts per million) of a pesticide in the air or water sufficient to kill half of the test animals exposed to the pesticide.

The smaller the LD₅₀ or LC₅₀ value, the more toxic the pesticide.

The acute toxicity of a pesticide is indicated on the label by a precautionary symbol, word, and statement. It is determined by measuring the LD₅₀ or LC₅₀ of the pesticide.

Laboratory tests are conducted on a number of standard test animal species (e.g., mice or rats) to determine LD₅₀ or LC₅₀. The values for animal trials are used to determine probable LD₅₀ or LC₅₀ values for people.

You will not find the LD₅₀ value on the label. Rather, estimated LD₅₀ and LC₅₀ values for a pesticide are indicated on the pesticide label using precautionary symbols or pictograms, signal words, and/or statements. The LD₅₀ value forms the basis for determining whether a pesticide is slightly, moderately, or highly toxic. This will determine which signal word must appear on the label.

Symptoms of Acute Pesticide Poisoning

Symptoms of acute pesticide poisoning range from being mild and flu-like to severe and debilitating. Acute pesticide poisoning symptoms can appear within a few minutes or up to 96 hours later. Symptoms of acute poisoning are divided into three levels of severity. Levels and symptoms are general for all pesticides. These include:

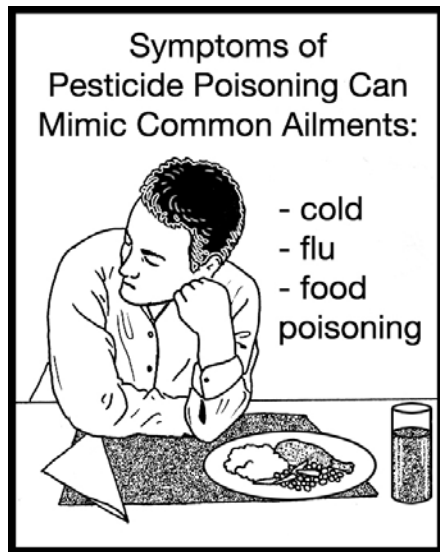


Figure 4-2: Pesticide poisoning can mimic other common illness.

- **Mild symptoms** include: headache, feeling tired, loss of appetite, dizziness, weakness, nervousness, nausea, sweating, diarrhea, weight loss, thirst, moodiness, and irritation of the skin, eyes, nose, and/or throat.
- **Moderate symptoms** include: nausea, trembling, loss of coordination, excessive saliva, blurred vision, tightness of throat or chest, laboured breathing, flushed or yellow skin, stomach cramps, vomiting, diarrhea, confusion, sweating, rapid pulse, and coughing.
- **Severe symptoms** include: vomiting, loss of reflexes, trouble breathing, increased breathing rate, muscle twitching, pin-point pupils, convulsions, unconsciousness, thirst, fever and death.

People working with or around pesticides must know the symptoms of poisoning. This will allow them to limit exposure and put preventive actions or first aid procedures in place. Pesticide products do not all have the same poisoning symptoms. Applicators and handlers of a pesticide should be able to recognize symptoms based on the type of pesticide being used. Symptoms of poisoning are described in MSDSs and on pesticide labels.

Always know the symptoms of poisoning that can occur from exposure to the pesticides you are handling. Share this information with your family and co-workers.

A doctor or Poison Control Centre should be contacted at once if anyone who may have come into contact with a pesticide exhibits symptoms of poisoning. Give them any precautionary statements (such as an antidote) from the label and the P.C.P. Act Registration Number. Medical staff can use this information to make a diagnosis and give advice.

Those who handle or apply a pesticide should know the precautionary statements on the secondary panel of the pesticide label. Medical staff may request this information if a poisoning occurs.

Table 4-1: Lists of Pesticides and Their Poisoning Symptoms.

<i>Pesticide Group</i>	<i>Examples</i>	<i>Typical Symptoms</i>
Organochlorines	endosulfan, lindane, methoxychlor	apprehension, nausea, vomiting, weakness, excitability, dizziness, disorientation, twitching, convulsions.
Organophosphates	Guthion (azinphos-methyl), Dyfonate (fonofos), Lorsban (chlorpyrifos), diazinon, dichlorvos, malathion, parathion	headaches, dizziness, weakness, tremors, nausea, diarrhea, blurred vision, convulsions.
Carbamates	Temik (aldicarb), Furadan (carbofuran), Sevin (carbaryl), Lannate (methomyl)	headaches, dizziness, weakness, tremors, nausea, diarrhea, blurred vision, convulsions.
Dinitrophenols	dinoseb, Karathane (dinocap), DNOC	fever, sweating, rapid breathing, rapid heart rate.
Bipyridyliums & Pyridyliums	Reglone (diquat), Gramoxone (paraquat)	respiratory distress, lung damage.
Fumigants	methyl bromide, Telone (1-3 dichloropropene), Vapam (metam-sodium), chloropicrin	double vision, slurred speech, uncoordination, chemical pneumonia, kidney damage.
Dithiocarbamates & Thiocarbamates	ziram, maneb, Eptam, Surpass (vernolate)	irritation of the eyes, skin, nose, and lungs, nausea, vomiting, muscle weakness.
Chlorophenoxy	2,4-D, MCPA	skin rash, muscle weakness, convulsions, coma.

<i>Pesticide Group</i>	<i>Examples</i>	<i>Typical Symptoms</i>
Petroleum Products	kerosene, solvent distillate, diesel oil	nausea, vomiting, cough, irritation to lungs, central nervous system depression.
Anticoagulants	warfarin, diphacinone, brodifacoum	nosebleeds, bleeding gums, abdominal pains, weakness.

Effects of Chronic Toxicity

Chronic toxicity is an adverse response to a pesticide exposure that persists over time.

Chronic effects are often permanent. These result from single or repeated exposures. Chronic effects include:

- Skin irritation
- Weight loss
- Organ damage
- Tumours
- Nerve damage
- Birth defects

Chronic effects are more difficult to recognize than acute effects. There is no standard measure such as the determination of LD₅₀ or LC₅₀ values. Chronic effects can occur:

- As a complication of an acute exposure
- As a slowly progressive condition
- As the development of negative health effects years later

Symptoms of chronic or long-term exposure may not develop for days, months, or even years. Some people are more prone to be affected by pesticides than others.

In Review

Toxicity is the ability of a pesticide to cause harm. Acute toxicity refers to an injury or symptom that appears within a few minutes to several days after exposure. Acute toxicity can result from a single exposure or a series of exposures. This often occurs within 24 hours, but it can take up to 96 hours before symptoms occur. Symptoms may appear as mild or severe, depending on the level of exposure. Some people are more prone to be affected by pesticides than others.

The acute toxicity for each pesticide is found by measuring the dose or concentration required to kill half of the test animals. This is referred to as Lethal Dose 50% (LD₅₀) or Lethal Concentration 50% (LC₅₀). The lower the value of the LD₅₀ or LC₅₀, the higher the toxicity of the pesticide.

Exposure to pesticides can cause long-term health effects without causing acute effects. Long-term effects are called chronic toxicity.

Applicators can protect themselves from acute and chronic toxicity when handling pesticides by wearing the recommended personal protective

Exposure

Exposure occurs when you come in contact with a pesticide. The higher the level of exposure to a pesticide, the greater the risk. High levels of exposure, even to a pesticide having a low toxicity, can create risk. An unprotected applicator, working throughout the entire spray season with a pesticide having a low toxicity, is still at some risk because the level of exposure has been increased. However, by eliminating or minimizing exposure to a very toxic pesticide, risk can be minimized.

$$\textit{Risk} = \textit{Toxicity} \times \textit{Exposure}$$

Routes of Exposure

A toxic effect can only occur if there is exposure. The risk equation shows that by reducing exposure to a pesticide, associated risk is also reduced. Pesticide handlers need to know how and where exposure can occur, so that they can take action to prevent or reduce risk. Exposure can result from inhalation, ingestion, dermal absorption, or absorption of a pesticide through the eyes.

Inhalation



Inhalation exposure results from breathing in airborne particles of a substance. Fine powders, spray droplets, vapours, or gases can be inhaled into the lungs. When the pesticide reaches the lungs, it can damage the lungs directly, or it can be absorbed into the bloodstream and cause poisoning elsewhere in the body. Risk of inhalation exposure is increased when using:

- High spray pressures that produce small droplets
- An ultra low volume (ULV) product
- Fogging equipment

Small droplets can be inhaled into the lungs where they are easily absorbed into the body. Unprotected workers exposed to vapours in enclosed spaces (e.g., cleaning up a spill in a storage area or application in a greenhouse) are also at high risk from inhalation exposure. In a confined space, the pesticide is not dispersed and can continue to expose workers. Some, but not all, pesticides produce vapours that have an unpleasant smell to warn of their presence. Most pesticides that are more likely to produce vapours will have a warning on the label, and label directions will instruct the applicator to wear a respirator.

PREVENTION AND PROTECTION

Reduce the risk of inhaling pesticides by:

- Wearing a proper fitted respirator (with a fresh pesticide-grade filter) when mixing and handling some volatile pesticides.
- Wearing a properly fitted respirator (with a fresh pesticide-grade filter) when working in an enclosed space where pesticides are applied or have been spilled.

- Staying away from areas where pesticides have just been applied.
- Following precautionary statements on the pesticide label.

Ingestion or Oral Exposure



Ingestion or oral exposure results from the intake of a substance through the mouth. Exposure can result from an accidental ingestion, a suicide attempt, or the eating of contaminated food. Ingestion most often occurs when pesticides are removed from their original container, or stored in food or beverage containers, and then are accidentally swallowed.

Serious poisonings may result when pesticides enter the body and are absorbed. Some pesticides may be petroleum-based or corrosive, as well as toxic. These can burn the mouth, throat, and stomach if ingested.

PREVENTION AND PROTECTION

Prevent pesticide exposure through ingestion:

- Store pesticides in original containers. Never use food, coffee, or soft drink containers.
- Keep pesticides away from children or unauthorized persons.
- Clean clogged nozzles correctly. Never put a nozzle to the lips or blow into it to clear a clog.
- Wash your hands and face after mixing, applying, or handling pesticides or pesticide containers. Do this before eating, drinking, or smoking.
- Store pesticides away from food, drink, or tobacco products.



Figure 4-3: Pesticide ingestion occurs easily. Never eat, drink or smoke when handling pesticides

Store pesticides only in original containers.

Dermal Absorption



Dermal absorption is the intake of a substance through the skin. It can result from:

- Contact with unprotected skin due from a splash back of the pesticide concentrate during mixing.
- Exposure to spray or dust during an application.
- Contact with residues on application equipment, treated crops, or contaminated personal protective equipment.

Dermal contact is the most common route of exposure when using pesticides.

The amount of pesticide absorbed through dermal exposure varies according to:

- Skin condition
- Location of exposure
- Pesticide characteristics

The body takes in pesticides more easily through broken skin, such as a cut, scrape, or abrasion. More of the pesticide may be absorbed into the body when the pesticide stays on the skin for a long time. Skin absorbs pesticides at different rates depending on the area of the body. Pesticides can be absorbed more quickly through skin covering the head, armpits, small of the back, genitals, and any area where moisture/sweating occurs.

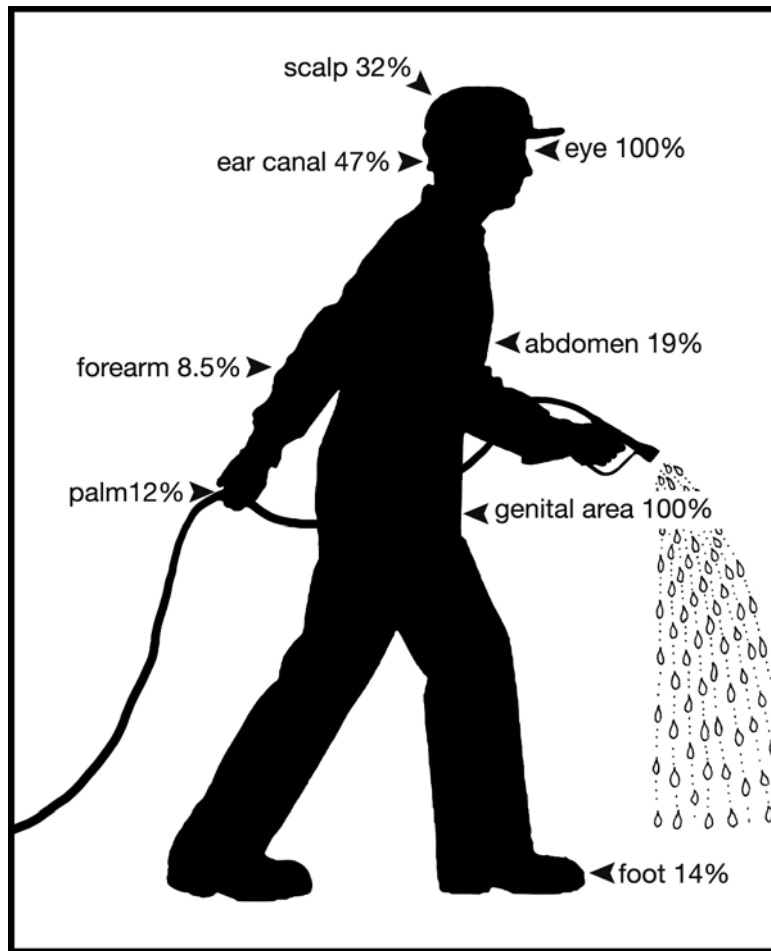


Figure 4-4: Absorption rates for different parts of the body.

Exposed hands and forearms are the most common sites of dermal absorption.

PREVENTION AND PROTECTION

Reduce the risk of exposure to pesticides through the skin:

- Keep personal protective equipment clean and in good order.
- Remove gloves after pesticide application and prior to clean up.
- Wash your hands and face right after handling pesticides or pesticide containers. Do this before eating, drinking, using the toilet, or smoking.
- Keep contaminated gloves or clothing away from the face and eyes.
- Immediately wash any area where a pesticide has been spilled on the body. Carefully remove any contaminated clothing.
- Follow re-entry times before going into a treated area.
- Store personal protective equipment, clean clothing, or personal items separate from where pesticides are stored or handled.
- Wear appropriate personal protective equipment (especially chemically resistant gloves) when:
 - Mixing pesticides
 - Applying pesticides
 - Handling pesticides
 - Handling empty containers
 - Cleaning up spilled pesticides

Ocular Exposure



Ocular exposure is the intake of a substance through the eyes. The eyes have many blood vessels that can absorb pesticides. If exposed to the eye, some pesticides can cause irritation or blindness (short-term or permanent). Pesticides can also enter the body through the eyes, and cause damage to other organs or parts of the body.

Precautionary statements and symbols on the pesticide label and in MSDSs will provide a warning for this. Exposure can result from a splash, pesticide drift, or rubbing the eyes with contaminated gloves.

PREVENTION AND PROTECTION

Care should be taken with eye protection. This is particularly so when handling concentrates. Eye protection (e.g., safety goggles or splash shield) can reduce ocular exposure. Most prescription eyeglasses do not provide proper protection from pesticide drift or splash from the side. Washing hands after handling pesticides can reduce the risk of exposure from rubbing the eyes.

- Measure and pour pesticide concentrates below eye level.
- Never wear contact lenses when handling pesticides.

In Review

Applicators need to know how and where exposure to pesticides can occur. Actions can then be taken to reduce risk. Pathways into the body for exposure to a pesticide are:

- The lungs (inhalation)
- The stomach (ingestion)
- The skin (dermal)
- The eyes (ocular)

Exposure can result from contact with pesticides at any stage of handling or use. This includes:

- Cleaning or maintenance of equipment
- Removing PPE
- Re-entry to a treated area
- Pesticide spill, splash, or drift

Follow label directions on the use of personal protective equipment to reduce exposure. To protect the lungs, a fitted respirator with a fresh pesticide-grade filter should be worn if there is a chance of fumes or vapours. The danger of ingestion can be reduced by storing pesticides only in original containers and by washing your hands and face after handling pesticides. Wearing proper gloves, boots, clothing, and removing the gloves last reduces the chance of dermal exposure. Safety goggles or a splash shield should be worn when there is a risk of pesticide splashing.

Minimizing Exposure and Associated Risk

Knowing how to handle pesticides and putting safety first allows applicators to reduce the risk of exposure to pesticides. Factors include:

- Attitude
- Method of application
- Personal protective equipment
- Risk management

Attitude

An applicator shows the right attitude by:

- Being safety conscious
- Practicing good personal hygiene
- Considering all routes of pesticide entry
- Taking the action needed to reduce exposure
- Practicing safe work habits
- Selecting pesticides of lower toxicity when possible

Method of Application

When applying a pesticide:

- Keep application equipment clean and maintained.
- Only spray when winds are within legal requirements (check with provincial regulations).
- Do not allow other workers or bystanders in the area.
- Avoid working in confined spaces – if you must do this, wear a respirator.

Use of Personal Protective Equipment

When handling or applying a pesticide, personal protective equipment should be:

- Clean
- In good repair
- Suited for use with the specific pesticide (as stated on the pesticide label)

Risk Management

To reduce the risks associated with pesticide use, applicators should follow safety practices when:

- Transporting, handling, and applying pesticides
- Cleaning personal protective equipment
- Cleaning and maintaining application equipment

In Review

To reduce the risk of exposure to pesticides, applicators must have a responsible attitude toward safety. A good attitude includes following label safety warnings and using approved personal protective equipment as needed. Cleaning and maintaining application equipment can lower the risk of exposure.

Summary

Risk associated with the use of pesticides is related to the toxicity of the pesticide being used and the amount of exposure to it. Decreasing toxicity and/or exposure decreases risk. Toxicity is the capacity of a substance to cause harm. Toxicity can cause short-term (acute) effects or long-term (chronic) effects.

Acute toxicity is the ability of a substance to cause ill effects which develop soon after exposure (i.e. a few hours to a few days). Measuring Lethal Dose 50% (LD_{50}) or Lethal Concentration 50 (LC_{50}) reflects acute toxicity. The smaller the value for the LD_{50} or LC_{50} , the more toxic the pesticide.

Chronic toxicity is the ability of a substance to cause ill effects, which last a long time. Symptoms are more difficult to see at the time of exposure than acute effects. Chronic effects are often permanent. Pesticides can cause chronic effects without acute effects.

Toxic effects of pesticides can vary with sex, health, age, weight, or prior exposure to other pesticides. Toxicity can also vary depending on the type of exposure. Risk tends to increase as the toxicity of the pesticide or duration of exposure increases.

Pesticides can enter the body through the lungs, mouth, skin, or eyes. Applicators must have a professional attitude on pesticide use and safety in order to limit the chance of exposure and risk. This includes wearing and taking care of personal protective equipment according to the label. Application equipment must be cleaned, maintained, and repaired. Risk should be considered when transporting, handling, or applying pesticides.

Self-test Questions

Answers are located in Appendix A of this manual.

1. Toxic health effects can vary with sex, health, age, or weight. **True or False?**

2. Which term, “Acute” or “Chronic” toxicity, refers to adverse effects which develop within a few hours or days after exposure to a pesticide?

3. The larger the number for acute LD₅₀, the more toxic the pesticide. **True or False?**

4. Effects of chronic toxicity are easy to detect and often reversible. **True or False?**

5. List four routes of pesticide exposure.

6. Most prescription eyeglasses provide protection from pesticide drift. **True or False?**

7. Storing pesticides only in original containers can reduce the risk of exposure to pesticides through ingestion. **True or False?**