Recognition and Management of Acute Pesticide Poisoning

WILLIAM M. SIMPSON, JR., M.D., and STANLEY H. SCHUMAN, M.D., DrPH
Medical University of South Carolina, Charleston, South Carolina

Most poisonings from pesticides do not have a specific antidote, making decontamination the most important intervention. For maximal benefit to the patient, skin, eye, and gastric decontamination should be undertaken while specifics of the poisoning are being determined. As in most illnesses and injuries, the history of the poisoning is of great importance and will determine specific needs for decontamination and therapy, if any exist. Protection of health care workers during the decontamination process is important and frequently overlooked. Skin decontamination is primarily accomplished with large volumes of water, soap, and shampoo. Gastric decontamination by lavage is indicated if ingestion of the poisoning has occurred within 60 minutes of patient presentation. Activated charcoal, combined with a cathartic, is also indicated in most poisonings presenting within 60 minutes of ingestion. With large volume ingestion poisonings, activated charcoal may be used after 60 minutes, but little data exist to support this practice. Syrup of ipecac is no longer recommended for routine use. The cholinergic syndrome "all faucets on" characterizes poisoning by organophosphates and carbamates. Organochlorine insecticides (lindane and other treatments for scabies and lice) can produce seizures with excessive use or use on large areas of nonintact skin. Nondipyridyl herbicides, biocides (including pyrethrins, pyrethroids, and *Bacillus thuringiensis*) rarely produce anything other than mild skin, eye, and/or gastrointestinal irritation on topical exposure or ingestion. (Am Fam Physician 2002;65:1599-604. Copyright© 2002 American Academy of Family Physicians.)

Members of various family practice departments develop articles for "Practical Therapeutics." This article is one in a series coordinated by the Department of Family Medicine at the Medical University of South Carolina, Charleston. Guest editor of the series is William J. Hueston, M.D.

Acute pesticide poisoning is an unusual and potentially fatal reason for visiting a family physician in the outpatient or emergency department setting. These episodes are likely to occur so infrequently that the physician must go through a steep learning curve with each encounter. However, a few items of history, knowledge of the small number of specific antidotes, and access to a limited number of resources (including the regional poison control center) will allow the physician to successfully initiate management for pesticide poisonings and most other poisons and to avoid mistakes from inexperience.

Because one of the potential measures of toxicity of an exposure is its duration, time is of the essence in recognizing pesticide poisoning.

Poisoning events involving pesticides account for about 4 percent of all poisonings and result in approximately 15 deaths per year, or 0.02 percent of all pesticide poisoning events reported.

Recognition of Poisoning

Sometimes pesticide poisoning is obvious. The patient is brought in with a container of pesticide, the pesticide residue is still in the patient's mouth, and the patient has symptoms that are characteristic of the labeled pesticide. Often, this ideal scenario does not exist. The exposure may be uncertain, the pesticide found with the patient may or may not be the ingested poison, and the patient may exhibit no symptoms or symptoms uncharacteristic of the presumed exposure. Because one of the potential measures of toxicity of an exposure is its duration, time is of the essence.

Decontamination

Decontamination must be undertaken while questions about the specific exposure

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are answered and supportive or specific therapy is being initiated.

Respiratory and skin protection is required for health care workers involved with treating patients that have been poisoned. Latex gloves are inadequate for protection from many chemicals; only rubber gloves are appropriate for use in a poisoning situation. A full face mask with an organic vapor/high efficiency particulate air filter should be used until skin and gastrointestinal decontaminations are completed.

Skin decontamination is accomplished with a shower using soap, large amounts of water, and shampoo. Skin folds, areas underneath fingernails, ear canals, and other portions of the body that may trap chemicals should be inspected and cleaned carefully. Contact lenses should be removed, so the eyes can be inspected and irrigated thoroughly if exposure is suspected. Contaminated clothing should be removed, bagged, and laundered carefully. Leather items usually cannot be decontaminated and should be bagged and treated as hazardous waste.

Gastrointestinal decontamination may be accomplished in several ways, each having specific indications and contraindications. The American Academy of Clinical Toxicology (AACT) and the European Association of Poisons Centres and Clinical Toxicologists (EAPCCT) have recently produced a position statement[1] on these therapies. A summary is included in the discussion of each potential therapy *(Table 1)*. These therapies are also discussed in greater detail in the fifth edition of *Recognition and Management of Pesticide Poisonings*.[2]

Additional Interventions

While skin and gastrointestinal decontamination are progressing, investigation into the background of the exposure should be ongoing. Family members, co-workers, and emergency response personnel should be interviewed to determine how the exposure occurred—inhalation, ingestion, skin contact, or combination (Is the environment safe now? Can others be protected from future exposure to poisoning risk?); if anyone else was exposed (Have all who were exposed been evaluated?); if there are other potential poisons involved (Are there symptoms that do not fit the presumed poison?); and if a specific antidote to the presumed poison exists (Has it been obtained and is it ready for administration?).

The label on the container of the pesticide involved is an invaluable resource for proper poisoning management. The Environmental Protection Agency requires a labeled statement of practical poisoning management and a telephone number for additional information. If the label is illegible or legible but more than a few years old, the regional poison control center should be able to provide up-to-date information on acute poisoning management.

With an unknown pesticide exposure, a land grant college Cooperative Extension Service agent who is familiar with local pesticide practices may be able to provide information about the most likely agrochemical in use in that area at a particular time of the year, on a particular crop, or in a specific environment.

The Extension Toxicology Network (EXTOX-

The Authors

WILLIAM M. SIMPSON, JR., M.D., is a professor in the department of family medicine at the Medical University of South Carolina, Charleston. Dr. Simpson received his medical degree from the Medical University of South Carolina and completed a family practice residency there.

STANLEY H. SCHUMAN, M.D., DrPH, is a professor in the departments of family medicine and pediatrics at the Medical University of South Carolina. Dr. Schuman received his medical degree from Washington University, St. Louis, and his doctorate in public health from the University of Michigan, Ann Arbor.

Address correspondence to William M. Simpson, Jr., M.D., Department of Family Medicine, Medical University of South Carolina, P.O. Box 250805, Charleston, S.C. 29425-0805 (e-mail: simpsowm@musc.edu). Reprints are available from the authors.

TABLE 1
Methods of Gastrointestinal Decontamination

Gastric lavage
Consider if patient presents within 60 minutes of ingestion.
Insert orogastric tube.
Attempt aspiration first, followed by 100 to 200 mL normal saline, then aspiration.
Relatively contraindicated in hydrocarbon ingestion
Neurologically impaired: cuffed endotracheal tube prior to lavage
AATC/EAPCCT Position Statement: gastric lavage not routinely used in poisonings. It is indicated only when potentially life-threatening amount of poison is ingested and the procedure can be done within 60 minutes of ingestion.
Cathartics
Used only in combination with activated charcoal
Sorbitol (1 to 2 mL/kg or 70 percent solution in adults, 1.5 to 2.5 mL/kg of 35 percent solution in children)
Single dose only
Not recommended in poisonings that produce diarrhea (organophosphates, carbamates, heavy metals in particular) or those that produce ileus (paraquat and diquat)
AATC/EAPCCT Position Statement: Cathartic alone has no place in management of poisoned patient. No definite indications for use of cathartics and its routine use with activated charcoal is not endorsed. If it is used, it should be as a single dose. Numerous contraindications: absent bowel sounds, abdominal trauma or surgery, intestinal perforation or obstruction, volume depletion, hypotension, or ingestion of a corrosive substance.
Activated charcoal
Used in conjunction with a cathartic if patient presents within 60 minutes of ingestion. (Some authorities would use beyond 60 minutes if serious poisoning is suspected.)
Dose: Adults and children >12 years, 25 to 100 g in 300 to 800 mL water; children <12 years, 1 gm/kg in 300 mL water
Dose may be repeated in 2 to 4 hours if bowel sounds are present.
Antiemetic suppository for nausea
Administered by nasogastric tube if unable to tolerate or unable to swallow
Protect airway if hydrocarbon-containing pesticide or unknown pesticide contents.
AATC/EAPCCT Position Statement: Activated charcoal should not be used routinely in management of poisoned patients. Charcoal appears to be most effective within 60 minutes of ingestion and may be considered for use for this time period. There is insufficient evidence to support or deny its use beyond 60 minutes after ingestion.
Syrup of ipecac
No longer indicated for routine use
Dose: adults and children >12 years, 15 to 30 mL followed by 240 mL water; children <12 years, 15 mL preceded or followed by 120 to 240 mL water; infants six to 12 months of age, 5 to 10 mL preceded or followed by 120 to 240 mL water
Dose may be repeated in all age groups if emesis does not occur within 20 to 30 minutes.
Contraindicated in patients with diminished airway protective reflexes, ingestion of hydrocarbons with aspiration potential, ingestion of a corrosive substance, or ingestion of a substance for which advanced life support may be necessary within the next 60 minutes.
AATC/EAPCCT Position Statement: Ipecac syrup should not be administered routinely in poisoned patients. If it is used, it should be administered within 60 minutes of ingestion. Considered only in alert patients who have ingested a potentially serious toxin. Same contraindications as listed above.

AATC/EAPCCT = American Academy of Clinical Toxicology/European Association of Poisons Centres and Clinical Toxicologists.

Information from American Academy of Clinical Toxicology, European Association of Poisons Centres and Clinical Toxicologist. Position statements. J Toxicol Clin Toxicol 1997;35, and Reigart JR, Roberts JR. Recognition and management of pesticide poisoning. 5th ed. U.S. Environmental Protection Agency, Washington, D.C., 1999.

TABLE 2
Most Common Pesticide Poisonings: Recognition and Management

Class	*Mechanism of action/toxicity*	*Signs and symptoms*	*Treatment*
Organophosphates Acephate (Orthene) Chlorphoxim (Baythion-C) Chlorpyrifos (Dursban, Lorsban) Diazinon Dimethoate (Cygon, DeFend) Ethoprop (Mocap) Fenitrothion (Sumithion) Fenthion (Baytex) Malathion (Cythion) Naled (Dibrome) Terbufos (Counter)	Inhibit cholinesterase leading to excess acetylcholine	CNS—anxiety, seizures, skeletal nerve-muscle junctions, autonomic ganglia—twitching, tachycardia, muscle weakness (nicotinic effects); peripheral cholinergic neuroeffector junctions—"all faucets on"—sweating, salivation, diarrhea, tearing (muscarinic effects); miosis (pinpoint pupils) most commonly, but 15 percent have mydriasis secondary to epinephrine release from adrenals due to nicotinic receptor stimulation.	1. Draw red cell cholinesterase and plasma pseudocholinesterase levels before therapy. Do not delay treatment while awaiting results. 2. Maintain and protect airway. 3. Supplemental oxygen 4. Atropine (preservative-free, if possible), 2 to 5 mg IV every 15 minutes (adults and children >12 years) until pulmonary symptoms controlled; children < 12 years, 0.05 to 0.1 mg/kg every 15 minutes; doses repeated as needed for symptom control (up to 24 hours, taper dose) 5. Pralidoxime (2-PAM, Protopam) IV, 1 to 2 g (adults) over 10 minutes, 20 to 50 mg/kg (<12 years) over 30 minutes; repeated in 1 to 2 hours and at 10- to 12-hour intervals as needed for symptom control; alternatively: continuous IV infusion 10 to 20 mg/kg/hr (up to 500 mg/hr) after initial bolus and continued for 24 hours 6. Furosemide (Lasix), 40 to 160 mg IV for pulmonary congestion remaining after full atropinization 7. Benzodiazepine for seizures (diazepam [Valium]), 5 to 10 mg slow IV push, repeated every 5 to 10 minutes to control or maximum 30 mg in adults; 0.2 to 0.5 mg/kg IV every 5 minutes to maximum of 10 mg in children >5 years, 5 mg in children <5 years; lorazepam may also be used
Carbamates Carbaryl (Sevin) Pirimicarb (Aphox, Rapid) Propoxur (Baygon) Timethacarb (Landrin) Other carbamates	Reversible cholinesterase inhibition (carbamoyl-acetylcholinesterase [AChE] complex dissociates much more easily and quickly than OP-AChE complex)	Cholinergic crisis with "all faucets on"; CNS depression with coma, seizures, hypotonicity in serious toxic exposures	1. Maintain and protect airway. 2. Optimize oxygenation/supplemental oxygen. 3. Atropine IV (preferably or IM) Adults, children >12 years, 2.0 to 4.0 mg every 15 minutes until secretions controlled; children <12 years, 0.05 to 0.10 mg/kg every 15 minutes until secretions controlled; continue 2 to 12 hours; continued signs of poisoning indicate need for more atropine. 4. Furosemide (Lasix), 40 to 160 mg, if basilar rales persist after atropinization 5. Pralidoxime not indicated in pure carbamate poisoning; may be necessary in mixed organophosphate/carbamate poisoning or unknown poisoning with cholinergic syndrome.
Organochlorines Chlorobenzilate Dicofol (Kelthane) Dienochlor (Pentac) Endosulfan Lindane (Kwell)	Induction of hyperexcitable state in central and peripheral nervous system by disruption of normal flow of sodium and potassium across the axon membrane; may antagonize GABA-mediated inhibition in CNS	Seizures, headache, dizziness, nausea, vomiting, paresthesias, incoordination, tremor/twitching following topical treatment for lice/scabies or accidental or intentional ingestion of liquid pesticide	1. Maintain and protect airway. 2. Ensure adequate oxygenation. 3. Seizure control with diazepam; adults, 5 to 10 mg IV push over 2 to 5 minutes, repeated every 10 minutes as necessary; children, <12 years 0.04 to 0.2 mg/kg every 10 minutes, monitoring airway closely; lorazepam may be used as an alternative. 4. IV fluids with dextrose (5 to 10 percent) and thiamine 100 to 500 ng/L 5. Dysrhythmias from rare myocardial irritant effect treated with lidocaine (1 mg/kg bolus, 2 to 4 mg/minute continuous infusion)

Table continues on next page

TABLE 2 *(continued)*

Class	*Mechanism of action/toxicity*	*Signs and symptoms*	*Treatment*
Biocides Pyrethrins/pyrethroids Allethrin Cyfluthrin (Baythroid) Cypermethrin (Barricade, Cymbush, Cynoff, Demon) Deltamethrin Dimethrin Fenothrin Fenvalerate Permethrin (Ambush, Dragnet, Nix, Pounce) Remethrin	Pyrethrins are derived from chrysanthemums; pyrethroids are synthetic compounds with longer half-lives; both can produce toxic effects on the nervous system but are not well absorbed and are effectively and quickly detoxified by mammalian liver enzyme systems.	The most severe symptoms are seizures, though highly uncommon unless highly exposed (usually through ingestion of large quantities); tremor, incoordination, salivation, vomiting; topical exposure can produce short-term paresthesias, especially of the hands and face; a small portion of the population (1 to 3 percent) is allergic to pyrethrins/pyrethroids—resulting in symptoms ranging from nasal stuffiness to asthma.	1. Skin decontamination by thorough washing with soap and water is suggested; vitamin E oil preparations are effective in preventing and treating paresthesias; corn oil and petrolatum are less effective. 2. Seizures controlled with benzodiazepines. 3. Standard antiallergy therapy for hypersensitivity reactions.
Bacillus thuringiensis Variety *aizawai* (Agree, Mattch) Variety *israelensis* (Aquabac, Skeetal) Variety *kurstaki* (Bactur, Dipel)	Wide range of products derived from several varieties of this organism; highly limited effects on mammalian systems	Mild irritative pulmonary symptoms in some involved in manufacturing process, not in mixers or appliers; theoretical risk of respiratory infection in immunocompromised individuals; single corneal ulceration reported, successfully treated with standard antibiotics; mild gastroenteritis with heavy ingestion	1. Symptomatic treatment following decontamination
Repellants Diethyltoluamide—DEET (Muskol, Off!, Skeeter Beater, Skeeter Cheater, Skintastic for Kids, others)	Mechanism of toxicity unknown	CNS depression followed by seizures; rare unless applied excessively under occlusion; mild skin irritating effects with repeated use; corneal and mucosal irritation; nausea and vomiting with ingestion and, rarely, hypotension, tachycardia with heavy dermal exposure	1. Decontamination 2. Control of seizures with benzodiazepines 3. Supportive care

CNS = central nervous system; IV = intravenous; IM = intramuscular; GABA = gamma-aminobutyric acid.

Information from references 1 through 5.

NET) is available at www.ace.orst.edu/info/extoxnet. The National Pesticide Information Center is available 9:30 a.m. to 7:30 p.m. EST at 800-858-7378 and at www.npic.orst.edu/index.html/. The American Association of Poison Control Centers (AAPCC) has recently established a national poison control hotline number (800-222-1222) that connects callers to the nearest poison control center. The AAPCC Web address is www.1-800- 222-1222.info/poisonHelp.asp.

Specific Therapy

The most common sources of pesticide poisonings, signs and symptoms, and specifics of management are addressed in *Table 2.*[1-5]

The label on the container of the pesticide involved is an invaluable resource for proper poisoning management.

Miscellaneous Solvents and Adjuvants

The liquid materials in which pesticides are dissolved and the solids on which they are adsorbed are chosen by the manufacturers to achieve ease in handling and application, and stability and maximal effectiveness of the active ingredient. The most commonly used solvents are petroleum distillates. Often, the odor that lingers after a pesticide application is that of the petroleum distillate rather than that of the active ingredient. Petroleum distillates may produce toxicities in themselves in large volume ingestions. Most adjuvants (emulsifiers, penetrants, and safeners) are potential skin and eye irritants of very low toxicity. Treatment of exposure is with decontamination by dilution with water.

Final Comment

With increasing use of integrated pest management and lower toxicity pesticides, acute pesticide poisoning will likely continue to be an infrequent reason for visiting a physician in the outpatient and emergency department settings. Because most of the commonly used pesticides have no specific antidote, decontamination of the skin, hair, eyes, and gastrointestinal tract is the primary mode of intervention. Recognition of the cholinergic syndrome associated with organophosphate and carbamate exposure allows for specific treatment of this increasingly rare event. Some members of other pesticide classes also have specific antidotes, making identification of the chemical necessary for optimal therapy. This emphasizes the need for teamwork with the patient, family, employer/supervisor, or Cooperative Extension Service agent.

Accidental pesticide exposures invite consideration of educational interventions to prevent recurrences, whether they be on an individual, family, community, or industry-wide scale. Because up to one half of pesticide poisonings are intentional in some age groups, particularly teenagers, the family physician must use the event as a trigger for screening for depression or other psychiatric illnesses.

The authors indicate that they do not have any conflicts of interest. Sources of funding: none reported.

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