

# PYRETHROID PESTICIDE ILLNESSES IN OCCUPATIONAL SETTINGS

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## ABSTRACT

**BACKGROUND** The use of pyrethroid insecticides is encouraged because they are considered nontoxic to humans. In 1999, over 500,000 pounds of pyrethroids were used commercially in California. Because of prevalent use, large numbers of workers are exposed to these insecticides. However, the role of pyrethroids in causing disease in exposed workers has not been profiled.

**METHODS** To characterize occupational pyrethroid-induced illness, a review was conducted of all cases reported by physicians, poison control centers and others to a state occupational pesticide illness surveillance system from January 1, 1998 to March 30, 2000.

**RESULTS** Out of 844 occupational exposures to non-disinfectant pesticides, 134 cases (15.9%) representing 45 exposure incidents were related to pyrethroids. Selected variables are summarized below:

Variables	Indoor Air Exposures	All Other Exposures
• No. illnesses related to pyrethroid pesticides (%)	38 (28.4)	96 (71.6)
• No. males (%) of illnesses in category	11 (29.0)	77 (80.2)
• Age: mean (range)	37.1 (19 – 55)	34.0 (13 – 68)
• No. workers per exposure incident: mean (range)	2.9 (1-10)	3.0 (1-49)
• Symptomatic (> 1 symptom): n (%)	37 (97.4)	81 (84.4)
• Type II pyrethroid involved: n (%)	24 (63.2)	78 (81.3)

**CONCLUSION** Pyrethroids were responsible for a large number of occupational pesticide illnesses. Illnesses occurred in a variety of workers and in a wide range of exposure scenarios, including indoor air exposures (over one-fourth of cases). The higher prevalence of females in indoor air exposures and males in non-indoor air exposures most likely reflects the workforce in these settings. The longer acting Type II pyrethroids were responsible for more illnesses than Type I compounds.



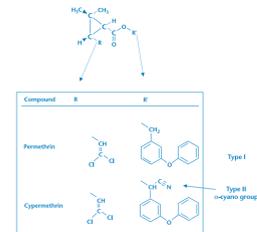
**Figure 2.** *Chrysanthemum cinerariaefolium*, the pyrethrum flower, is the source of natural insecticidal pyrethrins.

## BACKGROUND

Pyrethroid insecticides are the light-stable synthetic derivatives of pyrethrin, natural insecticidal extracts of the chrysanthemum flower.

### Pyrethroid pesticides are widely used

- Replacing more acutely toxic insecticides, e.g., organophosphates
- Considered non-toxic to humans
- Over 500,000 pounds of commercial use were reported in California in 1999
- Examples of use:
  - Structural pest control (offices, residences)
  - Agriculture (wide variety of crops, e.g., fruits, grains, ornamental flowers)
- Often used in combination with the synergist piperonyl butoxide



**Figure 1.** Chemical Structure of Type I and Type II Pyrethroid Insecticides

### Mechanism of Toxicity

- Sodium channel toxin
  - Stereospecific affinity for nerve membrane sodium channels
  - Prolongs inactivation, or sodium "tail current"
- Pyrethroids may be roughly categorized into Type I & Type II
  - Type I (noncyano pyrethroids)
    - ▲ Short sodium tail currents
    - ▲ DDT-like poisoning syndrome in animals (whole body tremor at high doses)
    - ▲ Examples: Permethrin, Resmethrin
  - Type II (α-cyano pyrethroids)
    - ▲ Longer sodium tail currents
    - ▲ Tremors, salivation, choreoathetosis, seizures at high doses (in animals)
    - ▲ Examples: Cypermethrin, Esfenvalerate
- In animals, toxicity enhanced by simultaneous high-dose exposure to some organophosphates

### Known Acute Human Health Effects of Pyrethroid Formulations

- Paresthesia, burning, itching, numbness, erythema
- Irritant and allergic contact dermatitis
- Airway hyperresponsiveness in asthmatics
- Dizziness, headache, fatigue, vomiting, diarrhea, fasciculations, seizures, pulmonary edema

## RESULTS

All results are for cases reported to CDHS between January 1, 1998 and March 30, 2001.

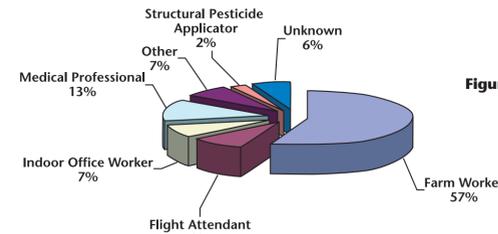
**Table 1.** Selected Characteristics of Occupational Pesticide Illnesses Involving Pyrethroid Insecticides.

• No. occupational pesticide illnesses:	844
• No. involving pyrethroid insecticides (% of all cases)	134 (15.9)
• No. male (% of pyrethroid cases)	88 (65.7)
• Age: mean (range)	34.9 (13 – 68)
• No. exposure incidents	45
• Average no. workers per incident (range)	3.0 (1 – 49)
• No. cases involving simultaneous exposure to pyrethroids and other pesticides (% of all pyrethroids cases)	87 (64.9)
• No. cases involving Type II compounds (% of pyrethroid cases)	102 (76.1)



**Figure 4.** Occupational pyrethroid illnesses were most frequently reported among farm workers. Pyrethroids are commonly used in lettuce production.

- Most cases involved exposure to multiple pesticides. In these cases, attribution of health effects to a particular pesticide category may be problematic.



**Figure 3.** Occupations of 134 Pyrethroid Illness Cases

- Illnesses occurred in a variety of other workers, including
  - ▲ Flight attendants (as a result of aircraft "disinsection")
  - ▲ Medical professionals (during treatment of contaminated patients)
  - ▲ Office workers (following structural pest control applications)
- A large incident involving exposure to multiple pesticides including pyrethroids affected farmworkers, office workers and medical professionals

## METHODS

In California, suspected occupational & pesticide illnesses are reportable conditions. Both physicians and poison control centers may report pesticide illness.

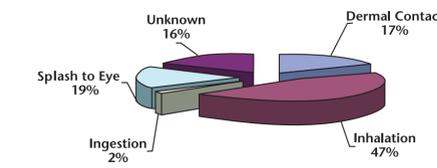
- The California Department of Health Services (CDHS) uses these reports to conduct surveillance for occupational pesticide illnesses. Disinfectants are excluded.
- Surveillance reports are supplemented with
  - Medical records
  - Field investigations of select cases
  - Interviews with workers, employers, regulatory agencies
  - County Agricultural Commissioner investigation reports of select cases
- A review was conducted of all cases that involved exposure to a pyrethroid insecticide reported to CDHS' occupational pesticide illness surveillance program between January 1, 1998 and March 30, 2001.
- Data was abstracted from initial reports and coded according to a system developed by the National Institute for Occupational Safety and Health. All cases that reported exposure to a specific pyrethroid insecticide were included in the analysis, regardless of final case classification.
- Data was entered into an MS Access (relational) database and analyzed using SAS.

**Table 2.** Signs and Symptoms Most Commonly Reported by 47 Cases Exposed to Pyrethroid Insecticides Only

Organ System	Signs & Symptoms
• Dermatologic	Erythema Irritation and pain Pruritus
• Ocular	Conjunctivitis Irritation and pain Lacrimation Pruritus
• Respiratory	Cough Dyspnea Pleuritic chest pain Upper respiratory pain/irritation
• Gastrointestinal	Nausea Vomiting
• Neurologic	Anxiety Headache Dizziness Tingling sensation (hands, face, etc.)
• Cardiac	Palpitations

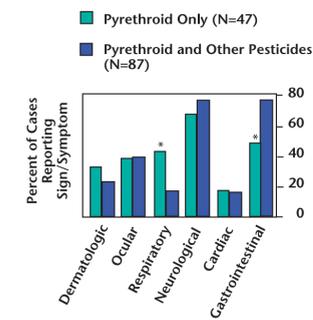


**Figure 9.** Product substitution, personal protective equipment and restricted entry intervals can prevent pyrethroid induced illness.



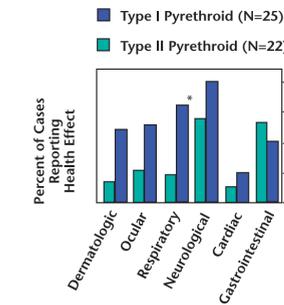
**Figure 5.** Route of Exposure for 134 Pyrethroid Illness Cases

- More than one route of exposure may have been reported for each case.



**Figure 6.** Symptoms and Signs Reported for Pyrethroid only vs. Multiple Pesticide Exposures

- The data did not allow distinguishing the roles of the various pesticides, inert ingredients, and synergists in producing these health effects.



**Figure 7.** Cases with Exposure to Pyrethroids Only: Type I vs. Type II Compounds

- 50% (11/22) of the Type I cases were flight attendants who reported prolonged exposure aboard aircraft on long flights.



**Figure 8.** Floriculture is one of several industries that use pyrethroid insecticides.

## CONCLUSIONS

- Exposure to pyrethroid insecticide formulations are associated with a large number of occupational pesticide illnesses in a wide variety of workers.
- Most cases involved simultaneous exposures to multiple pesticides. This may be due to either enhanced toxicity (synergistic effects) or prevalent use of pesticide mixtures.
- Respiratory and dermatologic effects were reported more frequently among workers exposed to (1) only pyrethroid pesticides compared to those exposed to multiple pesticides and (2) Type I pyrethroids compared to Type II pyrethroids.
- The longer-acting Type II (cyano) pyrethroids were associated with a larger number of occupational illnesses overall. This may be due to usage patterns or to the toxicity of these compounds.
- The shorter acting Type I pyrethroids were also associated with illness, particularly when prolonged exposure occurred in an enclosed space.

## RECOMMENDATIONS

- The potential for human health effects following exposure to pyrethroid insecticide formulations, alone or in combination with other pesticides, should be recognized by health care practitioners.
- Exposure to pyrethroids should be minimized through measures such as product substitution, administrative controls such as restricted entry intervals, and engineering controls such as appropriate personal protective equipment.