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OFFICE OF

PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

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MEMORANDUM

SUBJECT: Carbofuran - Review of Pesticide Poisoning Incident Data
DP Barcode D238109, Chemical #090601, Rereg. case #0101

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The following data bases have been consulted for the poisoning incident data on the active ingredient carbofuran (PC Code: 090601):

1) OPP Incident Data System (IDS) - reports of incidents from various sources, including registrants, other federal and state health and environmental agencies and individual consumers, submitted to OPP since 1992. Reports submitted to the Incident Data System represent anecdotal reports or allegations only, unless otherwise stated. Typically no conclusions can be drawn implicating the pesticide as a cause of any of the reported health effects. Nevertheless, sometimes with enough cases and/or enough documentation risk mitigation measures may be suggested.

2) Poison Control Centers - as the result of Data-Call-Ins issued in 1993, OPP received Poison Control Center data covering the years 1985 through 1992 for 28 organophosphate and carbamate chemicals. Most of the national Poison Control Centers (PCCs) participate in a national data collection system, the Toxic Exposure Surveillance System which obtains data from about 70 centers at hospitals and universities. PCCs provide telephone consultation for individuals and health care providers on suspected poisonings, involving drugs,

household products, pesticides, etc.

3) Department of Pesticide Regulation in the California Environmental Protection Agency - California has collected uniform data on suspected pesticide poisonings since 1982. Physicians are required, by statute, to report to their local health officer all occurrences of illness suspected of being related to exposure to pesticides. The majority of the incidents involve workers. Information on exposure (worker activity), type of illness (systemic, eye, skin, eye/skin and respiratory), likelihood of a causal relationship, and number of days off work and in the hospital are provided.

4) National Pesticide Telecommunications Network (NPTN) - NPTN is a toll-free information service supported by OPP. A ranking of the top 200 active ingredients for which telephone calls were received during calendar years 1984-1991, inclusive has been prepared. The total number of calls was tabulated for the categories humans incidents, animal incidents, calls for information, and others.

CARBOFURAN REVIEW

I. Incident Data System

Please note that the following cases from the IDS do not have documentation confirming exposure or health effects unless otherwise noted.

Listed below are reports of 19 individual incidents involving carbofuran in 1992. No further information on the disposition of these cases is available (they did not receive follow up to document exposure or health effects).

- e 1. A pesticide incident occurred in 1992, when an employee got carbofuran in their eyes. The employee experienced pinpoint pupils.
2. A pesticide incident occurred in 1992, when a worker was exposed to carbofuran while cleaning up the chemical after it had fallen off a truck.
3. A grower applied carbofuran and experienced pinpoint pupils.
- e 4. Two cases were reported where individuals got carbofuran in their eyes. Specific symptoms were not mentioned.
- e 5. A worker was near a field that had been sprayed with carbofuran and experienced blurred vision.
6. A worker, who is diabetic, sprayed a field with carbofuran and

experienced malaise.

7. A worker got carbofuran in their eyes while spraying a field and experienced blurred vision.
8. An individual got carbofuran in their face and specific symptoms were not mentioned.
9. A grower was smoking while applying carbofuran and experienced nausea, pinpoint pupils, and blurred vision.
10. A farmer spilled carbofuran on their hands while spraying the chemical. Specific symptoms were not mentioned.
11. A grower was exposed to carbofuran after cleaning out a sprayer and a hose and experienced nausea.
12. A worker applied carbofuran seven days earlier and experienced headaches, but has a history of migraines.
13. An individual experienced exposure to carbofuran that affected their eyes while their truck was being unloaded. Specific symptoms were not mentioned.
14. A worker sprayed carbofuran for 13 hours and experienced blurred vision.
15. An individual was exposed to carbofuran that splashed in their eyes. Specific symptoms were not mentioned.
16. An individual got carbofuran in their eyes. Specific symptoms were not mentioned.
17. Occupants of a home adjacent to agricultural fields were exposed to carbofuran. Specific symptoms were not mentioned.
18. A worker applied carbofuran all day and felt ill. Specific symptoms were not mentioned.
19. An individual was exposed to carbofuran that splashed in their eyes. Specific symptoms were not mentioned.

Listed below are reports of 26 individual incidents involving carbofuran in 1993. Note that exposure is described but specific symptoms are generally not mentioned in these reports. No further information on the disposition of these cases is available.

1. A pesticide incident occurred in 1993, when two cases were exposed to carbofuran while an area was being aerially sprayed.
2. A twelve year old girl got into an open bag of granules.

3. A worker was filling granular boxes on a planter and carbofuran got into their eyes.
4. A worker was mixing carbofuran which splashed on them.
5. A worker was spraying carbofuran and felt ill.
6. A male worker was using a hand sprayer to apply carbofuran.
7. A male worker was pumping carbofuran and was sprayed with the chemical when the hose came out of the drum.
8. A grower was cleaning application equipment and felt ill.
9. An individual was cleaning out an old barn and found open bags of carbofuran. He accidentally spilled the chemical and felt ill.
10. A grower was spraying carbofuran without personal protective equipment and became ill.
11. Children were playing near an area where carbofuran was being loaded into granular boxes and got granules into their eyes.
12. A worker was spraying carbofuran all day and felt ill.
13. A grower was cleaning out a planter and came in contact with the granules and felt ill.
14. A pesticide incident occurred when an airplane loader got granules on his arms during hot and humid weather and felt ill.
15. A pesticide incident occurred when a hose sprayer broke and a diluted spray got on an applicator.
16. A pesticide incident occurred when a grower, who was not wearing personal protective equipment, sprayed carbofuran all day and felt ill. *repair, maintenance, equip failure*
17. A pesticide incident occurred when a grower, who was not wearing personal protective equipment, was spraying carbofuran all day and felt ill. *Inadequate PPE*
18. A pesticide incident occurred when a grower, who was wearing minimal personal protective equipment, was spraying carbofuran all day and felt ill.
19. A pesticide incident occurred when a grower, who was not wearing a respirator, inhaled spray during a spray operation and felt ill.
20. A pesticide incident occurred when an applicator was cleaning spray tips and the spray rig malfunctioned and was turned on and sprayed the applicator.

21. A pesticide incident occurred when a scale repair company employee was servicing a scale at a manufacturing plant and felt ill.

22. A pesticide incident occurred when an applicator was sprayed with a mixture after a hose broke and felt ill.

23. A pesticide incident occurred when several commercial applicators and growers applied carbofuran to cotton and felt ill. All of the workers were not wearing personal protective clothing during the mixing and loading process.

24. In a lawsuit, the plaintiff alleged that carbofuran was applied by a crop dusting service, causing pain and suffering which resulted in the need for medical care and hospitalization.

25. A pesticide incident occurred when an individual got carbofuran in their eyes and four days later developed a dry tongue.

26. A pesticide incident occurred in 1993, when a grower got carbofuran on an area of his body and felt ill.

The following 36 cases were also reported in 1994. Symptoms were generally not reported and no further information on the disposition of these cases was reported.

1. A pesticide incident occurred when a worker was applying carbofuran which spilled onto their skin which was not washed off and felt ill.

2. A pesticide incident occurred when a worker used their mouth to clean clogged application equipment and felt ill.

3. A pesticide incident occurred when an individual applied carbofuran all day and felt ill.

4. In a lawsuit, the death of a man from acute myelogenous leukemia was a result of exposure to benzene containing products.

5. In a lawsuit, the plaintiff alleged that exposure to carbofuran caused them to feel ill.

6. In a lawsuit, the plaintiff alleged that exposure to carbofuran caused them to experience nausea, vomiting and abdominal cramps.

7. A pesticide incident occurred when an individual did not clean up after applying carbofuran and felt ill.

8. A pesticide incident occurred when a worker was cleaning up the chemical and got spray in their eyes.

9. A pesticide incident occurred when a decontamination team, who were not wearing personal protective equipment, were hired to clean up a container that was punctured and felt ill.
10. A pesticide incident occurred when a tractor driver with a closed cab that had an improper air filter drove through a spray cloud and felt ill. The cab did not have the proper type of filters.
11. A pesticide incident occurred when an individual was contaminated after opening carbofuran containers and felt ill.
12. A pesticide incident occurred when a worker spilled carbofuran on his arms and hands while mixing the spray.
13. A pesticide incident occurred when a worker was applying carbofuran and got spray on their face and in their eyes. Specific symptoms were not mentioned.
14. A pesticide incident occurred when an applicator was sprayed with carbofuran when applying the chemical and felt ill.
15. A pesticide incident occurred when an applicator was using an enclosed system and felt ill.
16. A pesticide incident occurred when a worker, who was not properly wearing personal protective equipment, was repairing application equipment and got carbofuran on his clothes and shoes.
17. A pesticide incident occurred when a worker got spray in their eyes while applying carbofuran.
18. A pesticide incident occurred when a grower got carbofuran in their eyes during a spray application.
19. A pesticide incident occurred when a worker accidentally got carbofuran in his eyes when a spray hose broke.
20. A pesticide incident occurred when an individual treated their children's playhouse with carbofuran, which is an illegal use of the chemical. One of the children felt ill.
21. A pesticide incident occurred when an applicator got carbofuran in their eyes while spraying the chemical.
22. A pesticide incident occurred when an applicator got granules in their eyes while filling the application equipment with carbofuran.
23. A pesticide incident occurred when an applicator got spray in their eyes and experienced blurred vision when the spray hose broke during the application.

24. A pesticide incident occurred when a worker was exposed to spray mist during an application and felt ill.
25. A pesticide incident occurred when an individual inhaled spray and felt ill.
26. A pesticide incident occurred when a worker was cleaning the sprayer and felt ill.
27. A pesticide incident occurred when a public utilities employee, who was wearing shorts at the time, entered a cotton field and felt ill.
28. A pesticide incident occurred when a worker was filling a measuring cone with an incorrect value and was sprayed with carbofuran. The worker did not change their clothes and felt ill about six hours later.
29. A pesticide incident occurred when a worker mixed chemicals and applied the spray and later ate lunch in the treated area and felt ill.
30. A pesticide incident occurred when an individual was contaminated with carbofuran during transportation of the chemical.
31. A pesticide incident occurred when applicators sprayed carbofuran and felt ill.
32. A pesticide incident occurred when workers were cleaning a spray tank and were contaminated and felt ill.
33. A pesticide incident occurred when a pilot felt ill following a spray application.
34. A pesticide incident occurred when a pilot sprayed carbofuran all day and after cleaning the spray tanks felt ill.
35. A pesticide incident occurred when an individual and his nine year old daughter were sweeping their trailer unit that was previously used to store seed corn and were exposed to dust and granular fragments. Before the man swept the unit, he removed the seed corn bags. They both experienced dizziness, headaches, nausea, and increased salivation which resolved within 24 hours.
36. A pesticide incident occurred when eighty-five workers entered a field to perform seed production related activities two days after carbofuran was applied to the seed corn. Half of the workers experienced dizziness, headaches, and blurred vision. Three of the workers stayed overnight in the hospital after receiving atropine treatment.

The following 26 cases were also reported in 1995. Symptoms in many cases were not reported and no further information on the disposition of these cases was reported.

1. A pesticide incident occurred when a forty year old man and a thirteen year old male child were standing about twenty feet from a barn where carbofuran and chlorpyrifos were being mixed. They experienced weakness, nausea, shortness of breath, and vomiting.
2. A pesticide incident occurred when a worker was cleaning a sprayer and got carbofuran in their eyes.
3. A pesticide incident occurred when an applicator was applying carbofuran and got the chemical on their clothing. The worker did not wash or change their clothes and experienced nausea and headaches.
4. A pesticide incident occurred when a worker was spraying carbofuran which got in their eyes. They experienced pinpoint pupils.
5. A pesticide incident occurred when an applicator was drenched with a diluted carbofuran spray when the hose on the sprayer broke and felt ill.
6. A pesticide incident occurred when an applicator was spraying carbofuran and felt ill.
7. A pesticide incident occurred when an applicator got a small drop of carbofuran on their arms while mixing the chemical. Later that day, the worker experienced blurred vision.
8. A pesticide incident occurred when an applicator was spraying carbofuran and the spray got on the worker. The worker experienced vomiting.
9. A pesticide incident occurred when a worker was drenched with one half of a tank of diluted spray and felt ill.
10. A pesticide incident occurred when an applicator, who was not wearing a respirator, inhaled spray and felt ill.
11. A pesticide incident occurred when a child ate treated seed which was thought to have been candy and felt ill.
12. A pesticide incident occurred when a worker was cleaning a spray rig and the diluted spray got in their eyes and felt ill.
13. A pesticide incident occurred when an applicator inhaled dust from the granules while applying carbofuran and felt ill.
14. A pesticide incident occurred when an applicator got spray in their eyes after a hose broke.

15. A pesticide incident occurred when an applicator, who wore a respirator and a short sleeve shirt, applied carbofuran aeriially and experienced light headiness which subsided in one to two hours.

16. A pesticide incident occurred when a worker, who was wearing a respirator, was using an air hose to clean equipment in a seed treating plant. Hospital personnel discovered that the worker had an irregular heartbeat.

17. A pesticide incident occurred when two workers applied carbofuran and experienced vomiting and headaches.

18. A pesticide incident occurred when a worker was drenched with diluted carbofuran when a hose broke during the transfer of the chemical from a tender to the rig.

19. A pesticide incident occurred when an individual got carbofuran in their eyes.

20. A pesticide incident occurred when an individual was hand spraying spruce trees and the wind blew the spray into their eyes and face.

21. A pesticide incident occurred when a worker was cleaning a spray tank and felt ill.

22. A pesticide incident occurred when an individual was cleaning spray equipment and felt ill.

23. A pesticide incident occurred when an individual spilled diluted carbofuran on their body area.

24. A pesticide incident occurred when an applicator was sprayed in the face when the hose broke on the sprayer and experienced pinpoint pupils.

25. A pesticide incident occurred when a farm worker reentered a field treated with two chemicals three hours later without personal protective equipment and experienced headaches.

26. A pesticide incident occurred when a grower was cleaning a spray line and felt ill.

The following 32 cases were also reported in 1996. Symptoms in many cases were not reported and no further information on the disposition of these cases was reported.

1. A pesticide incident occurred when a worker got carbofuran in their eyes and experienced blurred vision.

2. A pesticide incident occurred when several worker violated safe practices while applying carbofuran and felt ill.

3. A pesticide incident occurred when a worker was cleaning spray equipment and got carbofuran in their eyes.
4. A pesticide incident occurred when a grower inhaled spray and got carbofuran on their body area while cleaning the sprayer and felt ill.
5. A pesticide incident occurred when six workers were using defective masks during spray application and felt ill.
6. A pesticide incident occurred when a worker got carbofuran in their eyes while working with spray equipment.
7. A pesticide incident occurred when a pilot crashed an airplane while they were applying carbofuran.
8. A pesticide incident occurred when an applicator was drenched with a diluted spray when the application hose broke and felt ill.
9. A pesticide incident occurred when a worker got spray in their eyes after the application hose broke.
10. A pesticide incident occurred when an individual applied carbofuran and felt ill.
11. A pesticide incident occurred when workers were mixing and loading carbofuran and felt ill.
12. A pesticide incident occurred when a worker was cleaning contaminated spray equipment and felt ill. The worker was exposed for more than eight hours and removed personal protective equipment near the end of the day due to the heat.
13. A pesticide incident occurred when a worker was cleaning spray equipment and got diluted spray in their eyes and experienced blurred vision.
14. A pesticide incident occurred when a worker, who was not wearing personal protective equipment, was fixing a sprayer and felt ill.
15. A pesticide incident occurred when a worker, got undiluted carbofuran in their eyes and experienced blurred vision.
16. A pesticide incident occurred when a worker got carbofuran on their body area after remixing a diluted spray mixture that was left out overnight and felt ill.
17. A pesticide incident occurred when a worker was cleaning out a tank and got carbofuran on their body area and felt ill.
18. A pesticide incident occurred when an individual, who was applying carbofuran all day got the chemical on his skin and

inhaled the product. The individual experienced nausea, vomiting, diarrhea, sweating, and headache.

19. A pesticide incident occurred when several workers, who were hired as detassellers and were not wearing personal protective equipment, entered a field forty-eight hours after it was treated with carbofuran and felt ill.

20. A pesticide incident occurred when an applicator, who was not wearing personal protective equipment, sprayed carbofuran and felt ill and experienced headaches, and sore eyes.

21. A pesticide incident occurred when an individual experienced headaches and dizziness for three days after a corn field was treated about seventy-five yards from their home. The symptoms persist when the individual is both at home and away from their home.

e 22. A pesticide incident occurred when a worker was cleaning spray equipment and got diluted spray in his eyes.

23. A pesticide incident occurred when an individual was contaminated with carbofuran on the lower part of their body while unplugging clogged nozzles and felt ill.

24. A pesticide incident occurred when a worker, who was not wearing personal protective equipment, was fixing a sprayer and felt ill.

25. A pesticide incident occurred when a crop duster applied carbofuran for several days and experienced a pounding chest, weakness, nausea, and persistent sweating.

26. A pesticide incident occurred when several workers treated a cotton field with carbofuran and felt ill. Nine of the workers entered the wrong field and one of the workers felt ill.

✓ 27. A pesticide incident occurred when children detasseled corn that was treated with carbofuran and felt ill.

② 28. A pesticide incident occurred when an individual got carbofuran in their eyes.

29. A pesticide incident occurred when an individual spilled carbofuran on his skin.

30. A pesticide incident occurred when construction workers, who were not wearing personal protective equipment, were exposed to dust at a plant.

31. A pesticide incident occurred when two workers, who were not wearing personal protective equipment, were rinsing empty pesticide containers.

32. A pesticide incident occurred when an applicator got carbofuran on their face when a piece of an injection application unit broke.

The Minnesota Department of Agriculture surveyed state enforcement agencies to determine what pesticides were involved in spray drift. Among the thirty-two states responding to the survey, there was a total of 2,681 cases of drift complaints. Carbofuran was responsible for 2 complaints or less than one percent of the total.

II. Poison Control Center Data

Carbofuran was one of 28 chemicals for which Poison Control Center (PCC) data were requested. The following text and statistics are taken from an analysis of these data; see December 5, 1994 memo from Jerome Blondell to Joshua First.

The 28 chemicals were ranked using three types of measures: (A) number and percent occupational and non-occupational adult exposures reported to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects; (B) California data for handlers and field workers comparing number of agricultural poisonings to reported applications; and (C) ratios of poisonings and hospitalization for PCC cases to estimated pounds reported in agriculture for pesticides used primarily in agriculture.

A. Occupational and Non-occupational Exposure

There were a total of 874 carbofuran cases in the PCC data base. Of these, 418 cases were occupational exposure; 368 (88%) involved exposure to carbofuran alone and 50 (12%) involved exposure to multiple chemicals, including carbofuran. There were a total of 456 adult non-occupational exposures; 406 (89%) involved this chemical alone and 50 (11%) were attributed to multiple chemicals.¹ In this analysis, four measures of hazard were developed based on the Poison Control Center data, as listed below.

1. Percent of all accidental cases that were seen in or referred to a health care facility (HCF).
2. Percent of these cases (seen in or referred to HCF) that were admitted for medical care.
3. Percent of cases reporting symptoms based on just those cases where the medical outcome could be determined.

¹ Workers who were indirectly exposed (not handlers) were classified as non-occupational cases.

4. Percent of those cases that had a major medical outcome which could be defined as life-threatening or resulting in permanent disability.

Exposure to carbofuran alone or in combination with other chemicals was evaluated for each of these categories, giving a total of 8 measures. A ranking of the 28 chemicals was done based on these measures with the lowest number being the most frequently implicated in adverse effects. Table 1 presents the analyses for occupational and non-occupational exposures.

Table 1: Measures of Risk From Occupational and Non-occupational Exposure to Carbofuran Using Poison Control Center Data from 1985-1992^a

	Occupational Exposure	Non-occupational Exposure
Percent Seen in HCF		
Single chemical exposure	74.5 (68.2)	64.0* ⁵ (44.0)
Multiple chemical exposure	75.8 (69.8)	64.0* ⁵ (46.1)
Percent Hospitalized		
Single chemical exposure	28.8* ² (12.2)	27.3* ² (9.9)
Multiple chemical exposure	28.1* ² (14.3)	28.4* ³ (12.6)
Percent with Symptoms		
Single chemical exposure	93.3* ⁵ (85.8)	90.8* ³ (74.0)
Multiple chemical exposure	93.4* ⁴ (85.8)	91.2* ² (75.2)
Percent with Life-threatening Symptoms		
Single chemical exposure	1.0 (0.0)	1.1* ³ (0.0)
Multiple chemical exposure	1.2 (0.5)	1.5* ⁵ (0.05)

^a Extracted from Tables 2, 3, 5 and 6 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is median score for that category

* Top 25% of chemicals are ranked with a superscript of 1 to 7

Including exposure to multiple chemicals, carbofuran had the second highest percent hospitalized and the fourth highest percent with symptoms among occupational Poison Control Center (PCC) cases (Table 1). Among non-occupational cases with sufficient numbers reported, carbofuran ranked second in percentage of cases with symptoms and percent hospitalized and it was the fourth highest percentage of cases with life-threatening effects.

B. Ratios of poisoning - California Data

The incidence of **systemic poisoning cases** in agricultural workers reported to the California was compared to the number of applications of carbofuran. Those calculations, along with the median score for a total of 29 pesticides, are presented in the Table 2 below.

Table 2: Systemic Poisonings/1,000 Applications in Selected Agricultural Workers Exposed to Carbofuran in California, 1982-1989^a

Pesticide	Number of Appl.	Poisonings/1,000 Appl. (N) Primary Pesticide Only			Poisonings/1,000 Appl. (N) Multiple Pesticide Exposure		
		Handlers	Field Workers	Total	Handlers	Field Workers	Total
Carbofuran	29,126	.48 (14)	.38 (11)	.86 (25)	.52 (15)	.38 (11)	.89 (26)
Median		.21	.20	.41	.44	.50	1.02

^a Extracted from Table A5 in December 5, 1994 memo from Jerome Blondell to Joshua First; number in parentheses is the observed number of poisoned cases.

Carbofuran had the fifth highest ratio of handler poisonings per 1,000 applications in California when exposures to mixtures were included and the second highest when mixtures were excluded (See Table 7 in the December 5, 1994 memo.)

C. Ratios of Poisoning - U.S. Poison Control Data

Active registrations of carbofuran are for agricultural use exclusively. Ratios of the number of occupational Poison Control Center exposures to the reported pounds of the chemical used² were calculated. The results for carbofuran and the median for the 15 agricultural chemicals included in the analysis are presented in the Table 3 below.

Table 3: Ratios of Carbofuran Poisonings (PCC Data, 1985-1992) to Reported Use^a

Pesticide	Exposure Per Use	Poisonings Per Use	Health Care Referral Per Use	Hospital Admitted Cases Per Use
Carbofuran	.059* ²	.044* ²	.045* ²	.013* ²
Median	.033	.013	.027	.004

^a Extracted from Table 9 in the December 5, 1994 memo from Jerome Blondell to Joshua First

* Top 33% of chemicals are ranked with a superscript of 1 to 5

Among pesticides used exclusively in agriculture, carbofuran had the second highest ratio of exposures, poisonings, treatment, and hospitalization to estimated pounds active ingredient reported in use (Table 3). Taking all these factors together, carbofuran

² Gianessi, L.P., Puffer, C.A. Insecticide Use in U.S. Crop Production. Resources for the Future, Washington, D.C., 1992.

ranked second after mevinphos, in terms of potential poisonings risks to workers based on the indicators chosen.

D. Exposure in Children

A separate analysis of the number of exposures in children five years of age and under from 1985-1992 was conducted. For carbofuran, there were 57 incidents; 55 involved exposure to carbofuran. Compared to 16 other organophosphates and carbamates that 25 or more children were exposed to carbofuran cases were two to 2-2½ times as likely to be seen in a health care facility and nearly twice as likely to be hospitalized. Symptoms occurred twice as often for carbofuran and there was one case classified as life-threatening in a child under age six.

II. California Data - 1982 through 1993

Detailed descriptions of 67 cases submitted to the California Pesticide Illness Surveillance Program were reviewed. In 45 of these incidents, carbofuran was either used alone or with one other chemical (e.g., dicofol, dimethoate or 2,4-D) but carbofuran was judged to be responsible for the health effects. (Only cases with a definite, probable or possible relationship were reviewed.) Table 4 presents the types of illness reported by year.

Table 4: Types of Illnesses Reported as a Result of Carbofuran Exposure in California, 1982-1993^a

Year	No. of Cases	Illness Type			
		Systemic	Eye	Skin	Eye/Skin
1982	5	4	1	-	-
1983	2	-	2	-	-
1984	8	6	1	1	-
1985	3	3	-	-	-
1986	8	7	1	-	-
1987	3	3	-	-	-
1988	4	3	-	1	-
1989	2	2	-	-	-
1990	4	4	-	-	-
1991	1	1	-	-	-
1992	3	2	-	1	-
1993	2	1	1	-	-
Total	45	36	6	3	-

^a Multiple illnesses may be reported for each case.

The data were also tabulated by type of illnesses reported for individual activity categories; see Table 6 below.

Table 6: Illnesses by Activity Categories for Carbofuran Exposure in California, 1982-1993^a

Activity Category	Illness Category				
	Systemic	Eye	Skin	Eye/Skin	Total
Applicator	8	1	1	-	10
Mix/loader	11	4	-	-	15
Residue	1	-	1	-	2
Drift	2	1	1	-	4
Cleaning equipment	3	-	-	-	3
Packing*	5	-	-	-	5
Manufacture	3	-	-	-	3
Other**	3	-	-	-	3

Drift = anyone exposed in the course of application who was not involved in making the application; termed as coincidental prior to 1989; Applicator = workers involved in all forms of pesticide applications (ground, hand, other); Other = all activity categories not otherwise identified; Mixer/Loader = mixes and loads pesticides; Residue = exposure to residual pesticide (field, structural, other)

* Includes five packers exposed to illegal residues on figs.

** Includes 2 cases related to probable deliberate contamination of coffee.

The majority of incidents occur among handlers who mix, load, and apply chlorpyrifos in agricultural fields. Unlike other insecticides, cases due to exposure to field residue are relatively rare.

IV. NPTN

Carbofuran ranked 37th on the list of the top 200 chemicals for which NPTN received calls from 1984-1991, inclusively. There were 103 incidents involving humans and 23 involving animals. No further details are available on these cases.

V. LITERATURE REPORTS OF HUMAN POISONINGS

Baron (1991) summarized case reports in the literature due to carbofuran. Symptom onset is reported to be fairly rapid and initially may include headache, lightheadedness, weakness, and nausea. Later symptoms may include pinpoint pupils, blurred vision, abdominal cramps, excessive salivation and perspiration,

diarrhea, and vomiting. One incident was reported in a corn field where 150 teenagers reported for work to detassel corn that had just received a misapplication of carbofuran. Nausea and dizziness were initially reported and 74 reported to the hospital. Of these 74 teenagers, 45 received medical attention.

Baron (1991) reported on a suicidal case in Bulgaria where a woman ingested 60 mg of carbofuran (roughly 1 mg/kg) and survived with only modest inhibition of the cholinesterase (30-50% inhibition). Thus, 1 mg/kg appears to be a lower level effect dose in humans. In another suicide case, a 26 year old male ingested 345 mL of 45% mixture (estimated dose = $345 \text{ g} \times .45/70 \text{ kg} = 2220 \text{ mg/kg}$, assuming specific gravity = 1 g/mL) and was found dead with 99% inhibition of red blood cell cholinesterase (Ferslew et al. 1992).

VI. CONCLUSIONS

The 28 chemicals were ranked using three types of measures: (A) number and percent occupational and non-occupational adult exposures reported to PCCs requiring treatment, hospitalization, displaying symptoms or serious life-threatening effects; (B) California data for handlers and field workers comparing number of agricultural poisonings to reported applications; and (C) ratios of poisonings and hospitalization for PCC cases to estimated pounds reported in agriculture for pesticides used primarily in agriculture. The following conclusions apply to carbofuran:

1. There were a total of 931 carbofuran cases in the PCC data base. Of these, 418 cases (45%) were occupational exposure; 456 (49%) involved exposure among non-occupational adults (e.g., bystanders exposed to spray drift) and 57 (6%) involved exposure to children under age six. Of the 28 chemicals, only mevinphos ranked higher for occupational and non-occupational cases on the basis of percent hospitalized. Carbofuran also ranked high in terms of non-occupational cases (both children and adults) reporting symptoms or life-threatening symptoms.
2. Carbofuran still ranked high when number of incidents was adjusted for measures of use. In California carbofuran had the second highest ratio (not including parathion which has since had mitigation measures imposed) of poisonings per 1,000 applications (aldicarb was the highest). For field workers, on the other hand, this ratio ranked sixth among the 28 pesticides that were compared. Among 15 organophosphates and carbamates used exclusively in agriculture, carbofuran consistently ranked second (after mevinphos) on measures that compared number of exposures, symptomatic cases and hospitalizations adjusted for pounds of active ingredient in use.
3. Overall carbofuran was judged second among 28 pesticides on

measures of hazard derived from California and Poison Control Center data. Most of the risk from this product is due to use by pesticide handlers, especially mixer/loaders who handle the concentrated material. Less often, groups of people have been poisoned from spray drift and from exposure to field residue (e.g., handling figs with illegal residues or detasseling corn immediately after an application).

4. Detailed descriptions of incidents reported to the California Pesticide Illness Surveillance Program from 1982 through 1993 were reviewed. There were a total of 45 cases in which carbofuran was either used alone or in combination with other chemicals but was judged to be responsible for the health effects. The majority of the illnesses were of a systemic type (Table 4). The majority of incidents occur among handlers who mix, load, and apply carbofuran in agricultural fields (Table 5). Unlike other insecticides, cases due to exposure to field residue are relatively rare.

VII. RECOMMENDATIONS

Carbofuran warrants top priority for consideration of risk reduction measures now that the registration of mevinphos has been voluntarily canceled. The number and rate of poisoning cases due to carbofuran exposure reported to the Poison Control Centers and the California Pesticide Illness Surveillance Program is sufficient to warrant priority attention to risk reduction measures for this pesticide. The registrant has already proposed a number of measures designed address the more serious hazards of risk including spray drift warnings, closed mixing/loading systems, protective eyewear for workers involved in cleaning and maintenance, and additional training for handlers. Other regulatory restrictions to prevent acute poisonings by carbofuran should be in accordance with the Acute Worker Risk Strategy for the more toxic chemicals.

References

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