

Carbofuran Poisoning among Farm Workers

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Abstract

Accidental or intentional ingestion of carbofuran can produce a life-threatening syndrome that requires prompt diagnosis and treatment. This paper investigates unintentional carbofuran poisoning in farm workers.

Thirteen patients were admitted to the emergency department with carbofuran poisoning between January 2002 and August 2004 (2 female, 11 male). The patients had been poisoned while mixing the liquid form of carbofuran with seeds. Their hands were red on admission. Complaints most commonly reported by the patients on admission were nausea, vomiting, headache, weakness, dizziness and blurred vision. The most commonly observed signs were tachycardia, tachypnea, salivation, miosis, elevated blood pressure, and fasciculation. Three patients were agitated and one was lethargic on admission. We reviewed the patients' medical charts retrospectively, as well as the demographic data, intoxication route, clinical and laboratory presentations, and outcomes. We made the diagnosis according to a compatible exposure history and clinical findings.

The most commonly observed laboratory finding was hyperglycemia, which was found in 6 patients. Serum pseudocholinesterase level was low in only one patient. All the patients were cured and discharged from the hospital in good physical condition.

Rapid onset, mild illness and quick recovery are typical characteristics of acute occupational carbofuran poisoning. We conclude that public health efforts should educate farm workers about the dangers of pesticide application so that its threat can be diminished.

Key Words: Carbofuran, dermal route, emergency, farm workers, poisoning.

Introduction

THE CARBAMATES are a group of salts or esters of *N*-substituted carbamic acid. They are used as agricultural and household insecticides. Aldicarb, carbaryl, propoxur, and carbofuran are the ones most commonly used. Carbamate insecticides differ structurally from organophosphorus esters, but both types inhibit acetylcholinesterase. Cholinesterase inhibition caused by carbamate is labile, reversible and of short duration (1).

Carbofuran (2,3-dihydro-2,2-dimethyl-7-benzofuranylmethylcarbamate) is a carbamate insecticide used for the control of soil-dwelling insects in maize, oilseed rape, sorghum, sugar beet, sunflowers, vegetables and some fruits. It has two different formulations in the Turkish agricultural market. The first one has 35% active ingredient and is registered to use for seed application in corn and

sugar beet. The second one has 5% active ingredient and is restricted for use in foliar application for sugar beet. Carbofuran is one of the metabolites of benfuracarb and was detected in fatal human cases following benfuracarb ingestion (2). Carbofuran inhibits cholinesterase and is metabolized rapidly and completely by hydrolysis in rats; it has been assigned to the Ib toxic class by the World Health Organization (3). Carbofuran was introduced by Bayer AG and is widely used in many countries, including Turkey.

Several cases of fatal poisoning by carbofuran following accidental ingestion have been reported (1, 4, 5). We describe 13 cases of unintentional carbofuran poisoning via the dermal route.

Patients and Methods

Thirteen adult patients poisoned with carbofuran were admitted to Cukurova University's School of Medicine, Department of Emergency Medicine, between January 2002 and August 2004. Relatives of the patients brought the bottles which contained the liquid carbofuran apparently used. The carbofuran concentration used by our patients was 35%. We made the diagnosis according to a compatible exposure history and clinical findings.

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Accepted for publication March 2005.

We also reviewed their medical charts retrospectively, as well as the demographic data, intoxication route, clinical and laboratory presentations, and outcomes.

Observations

From January 2002–August 2004, 13 patients were admitted to a university-based emergency department with carbofuran poisoning. Two of them were female and 11 were male. Two of the patients were farmers who own their own land; the others were employed as farm workers. Table 1 shows the demographic data and the complaints of the patients on admission to the emergency department. There was no pathologic finding or underlying disease in the medical history of any of the patients. All poisonings were unintentional, and the route of poisoning was dermal in all cases. The patients were poisoned while mixing the liquid form of carbofuran with seeds by hand, and their hands were red on admission. The complaints most commonly reported by the patients on admission were nausea (85%), vomiting (69%), headache (46%), weakness (31%), dizziness (23%), and blurred vision (23%). Table 2 shows the initial physical signs and clinical findings. The most commonly observed signs were: tachycardia (62%), tachypnea (54%), salivation (46%), miosis (31%), elevated blood pressure (23%), and fasciculation (11%). Three patients were agitated and patient #9 was lethargic on admission. The most commonly observed laboratory finding was hyperglycemia, found in 6 patients (Table 3). Serum alanine aminotransferase

(ALT) and aspartate aminotransferase (AST) levels increased minimally in patient #1 but returned to normal limits after two days. Blood urea nitrogen, creatinine and electrolytes were within normal limits in all cases (Table 3). Pseudo-cholinesterase (PSE) samples were obtained from all patients on admission. PSE level was low only in patient #9 (Table 3) and it returned to normal after 2 days. PSE was assayed in serum with enzymatic colorimetric process (Integra 800 Roche®) in our hospital's central laboratory, where results could be obtained in one hour.

All of the patients were hospitalized. After diagnosis they were decontaminated by clothing removal and showering. All patients received supportive therapy, including oxygenation, intravenous fluids, monitoring, and medications according to their symptoms. During hospitalization, patients 2, 3, 9, and 11 received atropine (Table 2). The length of hospital stay was 1–2 days (Table 2). All of the patients were cured and discharged from the hospital in good physical condition.

Discussion

Carbamate insecticides, like organophosphates, inhibit acetylcholinesterase and produce similar clinical manifestations of acute intoxication. There are two main pharmacokinetic characteristics that distinguish carbamates from organophosphates. First, carbamate insecticides do not easily cross into the central nervous system. Central nervous system effects of carbamates are thus limited, although central nervous system dysfunction may still occur

TABLE 1
Demographic Data and Patient Complaints

	Patients												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Age (Years)	19	38	42	44	42	24	33	47	32	36	35	25	27
Gender	Male	Female	Male	Male	Male	Male	Male	Male	Male	Male	Female	Male	Male
Season	Summer	Summer	Summer	Spring	Spring	Summer	Summer	Summer	Spring	Summer	Spring	Summer	Summer
Place of poisoning	Rural	Rural	Urban	Rural	Rural	Rural	Rural	Rural	Rural	Urban	Rural	Urban	Rural
Occupation	Farm W	Farm W	Farmer	Farm W	Farm W	Farm W	Farm W	Farmer	Farm W	Farmer	Farm W	Farm W	Farm W
Type of exposure	Uninten	Uninten	Uninten	Uninten	Uninten	Uninten	Uninten	Uninten	Uninten	Uninten	Uninten	Uninten	Uninten
Route of poisoning	Dermal	Dermal	Dermal	Dermal	Dermal	Dermal	Dermal	Dermal	Dermal	Dermal	Dermal	Dermal	Dermal
Onset of Symptoms (hours)	6	4	3.5	3.5	6	6	4	6.5	1.5	7	5	5.5	7
	Complaints at Onset												
Headache	+	-	-	-	-	+	-	+	-	+	-	+	+
Nausea	+	+	+	+	+	+	+	-	+	+	+	+	-
Vomiting	-	+	+	+	+	+	-	-	+	+	+	+	-
Dizziness	-	+	-	-	-	-	+	-	+	-	-	-	-
Weakness	-	-	-	+	-	-	+	-	+	-	+	-	-
Blurred vision	-	+	-	-	-	-	-	-	+	-	+	-	-

Farm W = farm worker; Uninten = unintentionally.

TABLE 2
Initial Physical Signs and Clinical Findings, Treatment, and Patient Outcome

	Patients												
	1	2	3	4	5	6	7	8	9	10	11	12	13
Temperature °C	36.4	36.7	36.5	37.1	36.4	36.5	36.6	37.0	36.8	36.4	36.7	36.5	36.4
Heart rate/minute	112	121	82	94	114	81	132	79	52	81	92	122	91
Blood pressure (mm Hg)	120/80	140/100	110/70	130/85	120/75	120/80	130/90	110/70	100/60	120/80	110/70	140/100	120/80
Respiratory rate/minute	14	18	17	19	15	15	18	14	24	18	14	22	13
Mental status	Awake	Agitated	Awake	Awake	Awake	Awake	Agitated	Awake	Lethargic	Awake	Awake	Agitated	Awake
Pupil size	Normal	Miosis	Miosis	Normal	Normal	Normal	Normal	Normal	Miosis	Normal	Miosis	Normal	Normal
Salivation	+	+	+	+	-	-	-	-	+	-	+	-	-
Fasciculation	-	+	-	-	-	-	-	-	+	-	-	-	-
Treatment	Support	Atropine	Atropine	Support	Support	Support	Support	Support	Atropine	Support	Atropine	Support	Support
Length of hospitalisation (days)	1	2	1	1	1	1	2	1	3	1	1	2	1
Outcome	Cured	Cured	Cured	Cured	Cured	Cured	Cured	Cured	Cured	Cured	Cured	Cured	Cured

Support = supportive therapy.

TABLE 3
Laboratory Values of the Patients on Admission to the Emergency Department

	Patients												
	1	2	3	4	5	6	7	8	9	10	11	12	13
WBC (uL)	10,600	10,300	9,600	11,300	11,700	12,300	19,500	10,400	12,400	11,400	10,000	10,500	10,600
Hgb (g/dL)	14.0	9.5	13.5	14.1	15.7	14.4	14.5	13.8	15.2	10.5	13.1	12.9	14.1
Hct (%)	40.6	28.8	39.6	41.2	44.5	43.9	41.7	39.5	44.6	32.1	38.5	38.3	41.2
Plt (uL)	280,000	327,000	274,000	224,000	220,000	197,000	274,000	145,000	221,000	285,000	323,000	22,000	179,000
Glc (mg/dL)	124	152	95	101	138	96	177	102	93	87	92	125	112
AST (U/L)	59	16	17	18	17	31	23	27	34	21	19	15	32
ALT (U/L)	52	13	12	16	15	21	17	24	36	19	21	14	26
BUN (mg/dL)	21	18	11	13	13	17	20	16	12	14	17	19	22
Cr	1.3	0.7	0.6	0.8	0.9	1.1	0.7	0.6	0.8	0.9	1.0	0.6	0.7
Na (mmol/L)	145	136	141	142	139	142	138	138	139	141	140	144	139
K (mmol/L)	3.4	3.8	4.1	4.2	4.8	4.1	3.9	3.7	4.3	3.9	4.4	4.8	3.9
PSE (U/L)	11,373	6,854	7,542	9,541	10,421	10,753	7,848	11,575	4,132	10,457	8,745	9,653	12,654

WBC = white blood cell; Hgb = hemoglobin; Hct = hematocrit; Plt = platelet; Glc = glucose (normal range: 70–105); AST = aspartate aminotransaminase (normal range: 5–40); ALT = alanine aminotransaminase (normal range: >41); BUN = blood urea nitrogen (normal range: 8–25); Cr = creatinine; Na = sodium (normal range: 135–145); K = potassium (normal range: 3.5–5.1); PSE = pseudocholinesterase (normal range: 6400–15500).

after massive poisoning or may result from hypoxia secondary to pulmonary toxicity and respiratory muscle paralysis. Second, the carbamate-cholinesterase bond does not age, as in organophosphate poisoning; thus it is reversible, with spontaneous hydrolysis occurring within several hours (6). The result is briefer inhibition and less mammalian toxicity (1).

Carbofuran, an anticholinesterase carbamate, is commonly used as an insecticide, nematicide, and acaricide in agriculture practice throughout the world (7). It was first used commercially in 1967 and its use has grown rapidly over subsequent years (8). Its widespread use in agriculture is a po-

tential source of contamination of food, water and air, and consequent health effects risks (7). It is widely used in Turkey, especially in the Mediterranean region. The patients studied here had not paid attention to the usage and safety instructions on the bottle. Specifically, they had mixed the seeds with the liquid carbofuran with their bare hands. That is how the poisoning occurred. Although the instructions for using the compound were written on the bottles, they disregarded them, perhaps due to their limited literacy, relative inexperience and/or lack of supervision.

Carbofuran is most lethal when ingested. Acute toxicity is directly associated with the size

of the dose the organism receives (7). It is also highly toxic by inhalation, and moderately toxic by dermal absorption. Risks from exposure to carbofuran are especially high for persons with asthma, diabetes, cardiovascular disease, mechanical obstruction of the gastrointestinal or urogenital tracts, or those in vagotonic states (9). Symptoms of carbofuran poisoning include nausea, vomiting, abdominal cramps, diarrhea, excessive salivation, weakness, imbalance, blurring of vision, breathing difficulty, increased blood pressure and incontinence (8). Central nervous system abnormalities may occur in victims of severe carbamate poisonings, some of which may result from hypoxia caused by respiratory insufficiency or severe bronchorrhea (6). Complaints most commonly reported by our patients were nausea, vomiting, headache, weakness, dizziness, and blurred vision. The most commonly observed signs were: tachycardia, tachypnea, salivation, miosis, elevated blood pressure, and fasciculation. Only one of our patients was lethargic, and it may have been because of the length of exposure to the chemical and the concentration of carbofuran, since the PSE level was low only in that patient.

Our findings and the onset of the symptoms were similar to those of the patients reported by the Centers for Disease Control and Prevention (10). Their report mentioned that the patients had received supportive therapy; however, there was no information as to whether they were given atropine or pralidoxime. In our study, four of the patients received atropine in addition to supportive medication, because of co-existing symptoms such as salivation, fasciculation and miosis. The most commonly observed laboratory finding was hyperglycemia, found in 6 patients. Hyperglycemia, a nonspecific finding, has been reported many times in the literature (11, 12); it has been known to occur as a consequence of the increased accumulation of acetylcholine at the nerve endings following acetylcholine inhibition (13).

Clinical diagnosis of carbamate toxicity is based on the known or suspected history of carbamate use and the presence of cholinergic symptoms and signs. Isolated cases may be less recognizable, resulting in delays in diagnosis and treatment. Because cholinesterase inhibition by carbamates is rapidly reversible, cholinesterase testing may be unreliable in diagnosing carbamate poisoning (10). In our patients, carbofuran exposure was diagnosed as the cause of illness based on visual evidence (colored hands) and symptoms of cholinergic poisoning. However, laboratory evidence of cholinesterase depression was found in only one patient. Acetylcholinesterase inactivated by

carbamates spontaneously reactivates with plasma elimination half-lives of 1–2 hours, with clinical recovery in several hours, and rarely in more than 24 hours (14). Without continued exposure, cholinesterase inhibition reverses rapidly, and in non-fatal cases, the illness generally lasts less than 24 hours (15). In our series the duration of onset of symptoms varied from 1.5–6 hours, and the length of hospital stay was 1–3 days. Only patient #9, with cholinesterase depression, was hospitalized for 3 days. Four of our patients needed atropine during therapy.

The use of agricultural pesticides in developing countries carries potential risks. Frequently, the farm workers who use these pesticides are either insufficiently literate, informed or experienced to be fully aware of the health hazards involved. We conclude that public health efforts should be made to educate farm workers about the dangers of pesticide application so that its threat may be diminished.

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