

Organophosphate poisoning in a group of replacement heifers and dry cows

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Abstract — Terbufos ingestion caused acute organophosphate poisoning in 67 Holstein heifers and dry cows, 7 months to 5 years old. Overall mortality was 31%, with attack rates of 4% and 48% for the dry cows and heifers, respectively. Less severely affected animals were treated with atropine sulfate for 7 days.

Résumé — Empoisonnement aux organosphosphorés chez un groupe de génisses de remplacement et de vaches tarées. L'ingestion de terbufos a provoqué un empoisonnement aigu aux organosphosphorés chez 67 génisses et vaches tarées Holstein d'un âge variant entre 7 mois et 5 ans. La mortalité globale a été de 31 % avec des taux respectifs de 4 % et de 48 % pour les vaches tarées et les génisses. Les animaux les moins sévèrement touchés ont été traités au sulfate d'atropine pendant 7 jours.

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Five-and-a-half hours after a group of 42 heifers and 25 dry cows were put onto a pasture, 1 heifer was found dead, another was recumbent, and 2 more were depressed and salivating excessively. When examined 0.5 h later, 5 more animals had died, 5 were recumbent, and 6 were standing but salivating excessively. Affected animals also had serous nasal discharges, were moderately dyspneic, and 8% to 10% dehydrated. Rumens were hypomotile. Many animals were weak and depressed. Differential diagnoses included grass tetany, chemical poisoning, and black fly hypersensitivity. Four of the 5 recumbent animals were treated once, IV, with magnesium (4 mg/kg body weight (BW)) and calcium (17 mg/kg BW) (Cal-Dextro; Ayerst, Montreal, Quebec); corticosteroids (flumethasone; Flucort; Ayerst, Guelph, Ontario), 0.01 mg/kg BW; antihistamines (tripelemnamine; Vetastim; rogar/STB, London, Ontario), 1 mg/kg BW, and B-vitamins.

Postmortem examination of 3 dead heifers revealed moderate dehydration and fluid ruminal contents containing small numbers of canola seeds. Two days previously, the owner had removed approximately 5 kg of canola seed from a seed drill and placed it on a burn pile located in the pasture with the cattle. The canola seed had been treated with the organophosphate terbufos (Counter 15G; Cyanamid Canada, Toronto, Ontario).

Because of this history, a diagnosis of organophosphate poisoning was made.

The amount of atropine sulfate available was very limited, so treatment was restricted to those animals that were salivating but not recumbent. Up to 10 mg/kg BW of atropine sulfate (Ormond, Ancaster, Ontario) was administered to each animal, with one third of the dose given IV and the remainder, SC. Salivation and nasal discharge subsided after treatment, but dyspnea persisted.

Twenty-four hours later, 15 cattle had died and 15 others were showing signs of organophosphate poisoning. Treatment of clinically affected animals was temporarily discontinued due to a shortage of atropine sulfate. By day 4, 20 animals had died.

Two dead heifers were submitted for postmortem examination to confirm the diagnosis of organophosphate toxicosis. In addition to dehydration and fluid ruminal contents, lesions included serosal congestion throughout the small intestine, mucosal hemorrhage, and pulmonary edema and congestion. These findings are characteristic of organophosphate poisoning but are not pathognomonic for it (1,2). Histological examination revealed fibrinoid inflammation of the small intestinal subserosal vessels and myocardial vessels, pulmonary congestion and edema, and hypercontraction of skeletal and heart muscle.

Whole brain homogenates from both heifers were analyzed for levels of brain cholinesterase (ChE), and the results were compared with those obtained from an unexposed (control) cow that had died from other causes at another farm. The ChE level in the control brain was 0.170 units of enzyme activity per g of homogenate. The brain levels of the 2 affected heifers were 0.035 and 0.049 units per g (20% and 29% of the control, respectively). These findings supported the diagnosis of

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Omar Khan will receive a copy of *Saunders Comprehensive Veterinary Dictionary* courtesy of Harcourt-Brace Canada.

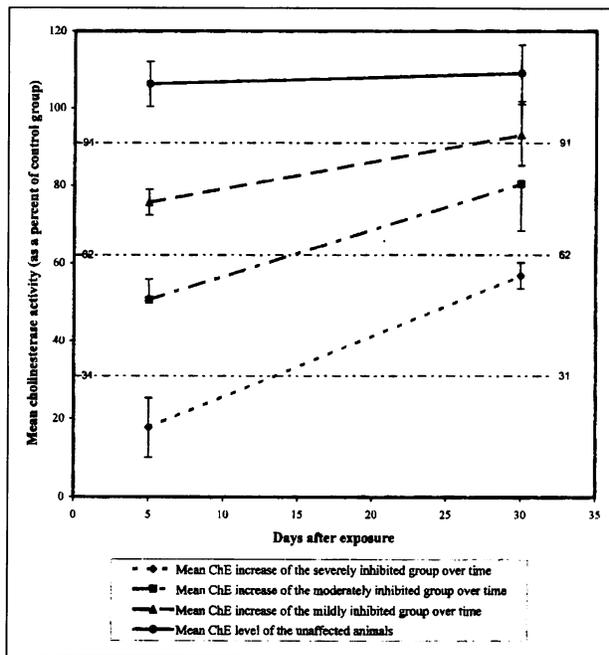


Figure 1. Mean whole-blood cholinesterase activity ($\pm s_x$) of 17 cattle, ages 9 mo to 5 y, 5 and 30 d after organophosphate exposure. Included are 5 clinically unaffected animals and 12 with clinical signs. s_x — standard error of the mean.

organophosphate-induced cholinesterase inhibition. The diagnosis of organophosphate poisoning was confirmed when terbufos was found in a toxicant screen of the ruminal contents from the 2 affected heifers.

Toxicological analysis of ethylenediamine tetraacetic acid (EDTA)-treated blood of the remaining 47 animals was performed on day 5 to identify the most severely affected animals. The modified Ellman photometric technique for assessing whole-blood ChE identified depressed enzyme levels in 12 animals. For the next 7 d, these animals were treated with atropine sulfate.

Because of the great variability of enzyme activity among herds, and the apparently elevated levels within this herd compared with laboratory control values, 5 animals were randomly selected to act as a group control. The controls had been in the field that contained the canola seed but, apparently, had not ingested any, as they had normal ChE levels and were clinically unaffected. Cholinesterase enzyme activity is clinically more meaningful when the average for an affected group is expressed as a percent of control values. In Figure 1, the results of 2 cholinesterase assays on days 5 and 30 are compared for a select group of 17 animals, 12 with decreased ChE activity and 5 apparently unaffected animals (not the control group). On the basis of these findings, the herd was divided into 4 groups.

The unaffected animals that had ChE levels of greater than 90% of the controls comprised the largest group (all data not shown). These animals had normal enzyme activity compared with the controls, indicating that they had ingested only very little or none of the poison. The remaining 3 groups consisted of animals with varying degrees of changes in ChE levels. In the mildly inhibited group, most animals were asymptomatic.

Although their blood ChE enzymes were low, the amount of terbufos ingested was apparently insufficient to cause significant acetylcholinesterase (AChE) inhibition. The animals in the moderately inhibited group had varying clinical signs, predominantly dyspnea, with a few more severely affected than the rest. Their blood ChE levels ranged from 31% to 61% of the control values. All animals in the severely affected group had marked dyspnea, soft feces, and ChE levels that were less than 30% of control values. One dry cow in this group was recumbent for several days.

The recumbent dry cow was treated with 1 kg of activated carbon powder (BDH Charcoal; BDH Chemicals, Toronto, Ontario) as a drench 72 h after exposure. She had a blood ChE level of 4% of control values, and, although she was able to rise and walk after treatment, she died on day 11.

To minimize further absorption of the organophosphate from the gastrointestinal tract, 25 kg of an industrial-grade granular carbon (Activated charcoal filter grade; Haycarb, Etobicoke, Ontario), was mixed with corn silage and fed to the 3 groups of affected animals.

One month after the poisoning, samples were taken from the animals that had previously had low ChE levels, the 5 unaffected animals, and 5 milking animals that had not been exposed to terbufos. The 5 milking animals acted as group controls, and their ChE levels were similar to the control values on day 5. The ChE levels of the affected animals had increased considerably after 30 d (Figure 1).

Active cholinesterase is present on newly synthesized RBCs. Boermans et al (3) reported that approximately 120 d is required for ChE levels to return to normal after terbufos toxicosis, a period corresponding to the lifespan of bovine RBCs. Although many of the animals in this herd did not have normal ChE levels (for this herd) by day 30, they made a more rapid recovery than did the animals in Boermans' study (3).

Hematological parameters on day 30 were within normal limits (data not reported). In contrast, Boermans et al (3) reported anemia in cattle about 1 mo after ingesting terbufos. However, those authors were unable to determine whether the anemia had existed prior to the poisoning or was a hematotoxic effect of terbufos.

Although organophosphate insecticides are considered relatively safe in mammals, which are able to metabolize and excrete these compounds efficiently (4), acute organophosphate poisoning is not uncommon in farm animals (5). Young, compromised, or clinically ill animals and pregnant females have been reported to be at higher risk of toxicosis (1,4,5). The toxic effect of organophosphates is caused by phosphorylation of cholinesterase enzymes (3,5) in nerve tissue, erythrocytes, serum, and liver. In cattle, greater than 90% of non-nerve tissue cholinesterases are present on RBCs, which act as a first line of defense by binding organophosphate that otherwise would bind to nerve AChE (3). The classical clinical signs of organophosphate poisoning occur when inactivation of AChE causes increased acetylcholine activity, which, in turn, causes overstimulation of the parasympathetic nervous system and the postganglionic cholinergic nerves of the sympathetic nervous system, with both muscarinic and nicotinic effects.

The classic signs of organophosphate poisoning include nasal discharge due to increased mucus secretion by bronchiolar glands, salivation, dyspnea due to bronchoconstriction, meiosis, and increased peristalsis and diarrhea with subsequent intestinal hypomotility and atony. Bradycardia and sweating may also be observed. These signs, referred to as visceral effects, are responsive to early treatment with atropine sulfate (2,5). However, animals may become refractory to treatment due to continued intestinal absorption of the organophosphate. Nicotinic signs include muscle fasciculations that cause fatigue and flaccid paralysis. Paralysis of the respiratory muscles, including the diaphragm, causes death. Nicotinic signs do not respond to atropine sulfate.

Respiratory signs, which are almost always present in organophosphate poisoning, result from both muscarinic and nicotinic effects. Restriction in lung expansion and increase in pulmonary airway resistance cause decreased dynamic lung compliance (6). A distended, fluid-filled rumen, as was observed at necropsy in these animals, may also compromise respiratory function. Pulmonary hypertension was observed in goats after experimentally-induced organophosphate poisoning had apparently caused left ventricular failure (6). Although pulmonary hypertension was not identified, it may have been present and contributed to the deaths in these animals.

Proper disposal of the carcasses of a large number of poisoned cattle may be problematic. At present, no legislation under the Ontario Ministry of Agriculture Food and Rural Affairs or the Canadian Food Inspection Agency regulates the handling of carcasses of poisoned animals. If public health and/or food safety appears compromised, the local municipal public health unit is empowered by the Ontario Health Protection and Promotion Act (8) to act as it sees fit to protect the public.

According to the Dead Animal Disposal Act of Ontario (7), a dead animal may be disposed of, within 48 h of death, in one of the following ways: (i) burial under at least 2 feet of earth, (ii) removal by a licensed collector, (iii) delivery to a laboratory for postmortem examination, investigation, or adjustment, or (iv) composting on the farm. At a rendering plant, parts of the carcass are likely to be processed into pet food or other

animal feed, which could pose a health risk to animals. The preferred method of disposal of poisoned carcasses is to label them as condemned material and have them processed for inedible rendering. This prevents potentially hazardous chemicals from reaching the food chain. Although there was a potential for groundwater contamination, the dead cattle described in this report were buried on the farm.

The severity of the organophosphate poisoning described in this report emphasizes the highly toxic potential of this group of chemicals. In all, 1 of 25 dry cows and 20 of 42 heifers died. Farmers must learn to handle these chemicals safely and not place themselves or others at risk. Having a reserve of atropine sulfate and activated carbon at a readily accessible site, such as the Ontario Veterinary College pharmacy, may prove invaluable in the event of another such incident. In addition, publicizing events of this nature through media releases may be helpful in reminding others who use these agents of just how dangerous they can be.

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