

Trichinosis from bear meat and adulterated pork products: a major outbreak in British Columbia, 1971

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Classically, trichinosis is transmitted to man by ingestion of pork products containing viable cysts of *Trichinella spiralis*. Although the disease is decreasing in incidence in man, it is still found from time to time in hogs in some areas of North America¹ and is carried by a hundred other animal species.² Among the wildlife animals that harbour this nematode, none is more closely involved in human infection than the bear.

Indeed, in recent years reports of ursine trichinosis have increased markedly. In the United States, Alaska, New York, Idaho and California have reported outbreaks of trichinosis traced to consumption of meat from black, brown or polar bears.³⁻⁸ In Canada outbreaks have occurred in Labrador, the Northwest Territories and Saskatchewan.⁹⁻¹¹

From 1949 to 1968 three isolated incidents of ursine trichinosis occurred in British Columbia. In 1949¹² a North Vancouver hunter contracted trichinosis by eating undercooked bear steak. During the fourth week

of his illness he sustained an uncommon complication when his right foot became cyanosed and painful. All symptoms were relieved by femoral embolectomy. Trichinae were identified in biopsies of his sartorius and gastrocnemius muscles and in remnants of the bear meat he had consumed. In 1960¹² three hunters north of Kamloops ate undercooked bear steaks and developed trichinosis. Sera from two of the hunters were reactive and serum from the third was weakly reactive in agglutination and complement-fixation tests for trichinosis. Remnants of the bear meat contained trichinae. In 1968¹² a man from Fernie developed trichinosis after eating bear meat. He had an eosinophilia of 28%; his serum was reactive in the precipitation and agglutination (1:64) tests for trichinosis.

As well as reporting the epidemiological and laboratory investigations that disclosed trichinosis in 17 persons who ate undercooked meat from the black bear, *Euarctos americanus*, this paper also emphasizes the danger to public health in North America of inclusion of inadequately processed bear meat in uninspected commercial "pork" products.

After a decade of low incidence trichinosis has now appeared as a large outbreak in British Columbia, referred to as the West Kootenay Trichinosis Outbreak of 1971. It was traced to consumption of inadequately smoked bear meat. During November and December 1971 epidemiological investigations discovered pa-

tients with trichinosis in five areas of the province (Fig. 1).

Index cases

This epidemic came to the attention of the West Kootenay Health Unit on November 10, 1971 when a family physician reported an unexplained illness in a patient from Castlegar. When admitted to hospital on October 29, 1971 this 56-year-old woman had fever, sore muscles, diarrhea and periorbital edema, associated with eosinophilia of 55%. She stated that she had been ill for four weeks and after some improvement had returned to work but relapsed the same day. Her 69-year-old friend developed similar but milder symptoms. The diagnosis of trichinosis was made on November 15 by skin tests and confirmed on November 16 by biopsy of the deltoid muscle of the younger woman (Fig. 2).

On October 7 both women had eaten cuts of smoked meat at a West Kootenay inn where they also purchased homemade smoked sausages. A few days later they became ill.

Epidemiological investigation

By alerting the Medical Health Officers of British Columbia, 15 more persons with trichinosis were discovered. All were linked, directly or indirectly, to the same inn where the two Castlegar women (#1, 2) had eaten. One man and four women employees (#3-7) regularly ate at the inn. One man, a local resident (#8), ate smoked bear meat and sa-

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lami sausage from the inn. A man from California brought smoked bear meat and smoked sausage from the inn to a Chilliwack home. The Chilliwack couple (#9, 10) and the Californian (#11) ate uncooked smoked sausage and cooked bear meat, while the son-in-law (#12) of the Chilliwack couple, visiting from North Vancouver, just ate uncooked smoked sausage. All four became ill. The wife of the Californian and the daughter of the Chilliwack couple ate no meat and were not ill. A second Chilliwack couple took the rest of the smoked sausage on a lengthy camping trip to Mexico; it is to be hoped that they cooked it well before eating it. After returning home the Californian (#11) suffered from severe "stomach flu" but did not consult a physician. Two men from Victoria (#13, 14) and two men from Kelowna (#15, 16) ate smoked meat and sausage while visiting the inn. Another man from Kelowna (#17) ate bear meat obtained from a hunter, presumably smoked at the inn.

Source of infection

Around mid-September this hunter had killed a large American black bear within one mile of the local open-faced garbage dump. He then asked a relative of the innkeeper to process it in return for about 20 kg. of the smoked meat. Inspection of the inn failed to discover any trace of bear meat. On November 17 the proprietor stated that the cold plate and smoked sausages contained only beef and pork products. He produced sales slips to show that he bought the pork from a federally-inspected meat-processing plant in Vancouver. Later

it was learned that during September bear meat was smoked at the inn by hanging large steaks, roasts and hams over sawdust fires in the homemade smokehouse for 12 to 14 hours. Before smoking, sausage meat was immersed in "hot" water for 15 to 20 minutes. The findings strongly support the epidemiological conclusion that bear meat and salami or smoked sausage containing bear meat transmitted trichinosis to at least 17 persons who ate meat from the inn during September and October.

Materials and methods

The tests performed included total and differential leukocyte counts, biopsies of deltoid or gastrocnemius muscle and Bachman intradermal injections. Sera were tested at the Institute of Parasitology, Macdonald College, McGill University for precipitation, agglutination and hemagglutination reactions, and at the Center for Disease Control, Atlanta, Georgia, for bentonite flocculation. Meat products were collected from the inn and from the larders of patients. The digest compressorium technique advocated by Simon and Stovell¹³ was used for detecting larvae in muscle. Digestion of cut muscle tissue for one and one-half to two hours before examination in the compressorium had the dual advantage of improving the clarity of larvae, whether living or dead, and of increasing the speed of their detection. Use of this technique made it possible to identify trichinae in "pork" sausage, even when bear meat could not be detected serologically. The Crime Laboratory, Royal Canadian Mounted Police, Vancouver,

using specific animal antisera, examined meat samples by precipitation tests to determine their species of origin.

Clinical features

So protean were the initial symptoms that the preliminary diagnosis was usually "stomach flu". In one patient appendicitis was suspected; in another, cholecystitis. A third patient with prominent periorbital edema was treated for sinusitis. To combat severe fatigue two young women took "iron pills". One woman with stiff jaw muscles was investigated for tetanus.

First symptoms were usually those of acute gastroenteritis with fever up to 40°C., prolonged diarrhea, severe fatigue and abdominal discomfort. After partial recovery six patients complained of myalgia and periorbital edema. In three patients edema appeared in chin, neck, forearms or ankles. One complained of swelling of the tongue and cheek, resulting in difficulty in opening the mouth. Three reported photophobia and difficulty in focusing. One had a maculopapular rash and another, large hemorrhagic skin lesions. One patient had splinter hemorrhages beneath the fingernails. One reported several bouts of epistaxis and mild cough shortly after the onset of illness. One patient had ECG changes suggestive of mild myocarditis. One became critically ill with bilateral pulmonary infarction and pleural effusion 47 days after onset of symptoms.

The clinical features in these 17 Caucasian patients are summarized in Table I. The incubation period

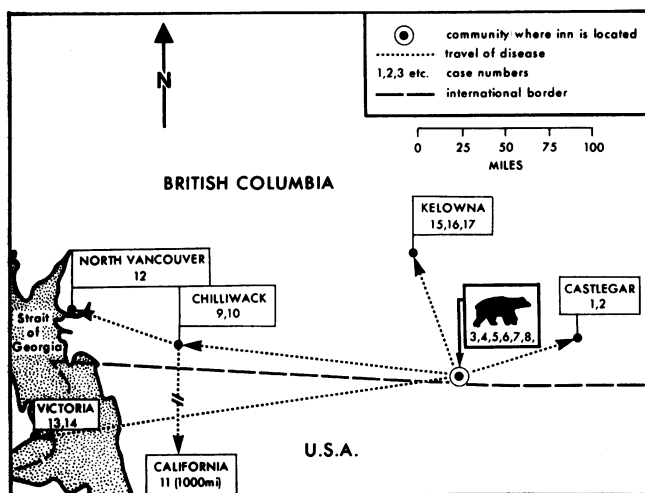


FIG. 1—Map showing spread of disease and geographical distribution of trichinosis cases in the British Columbia outbreak of 1971.

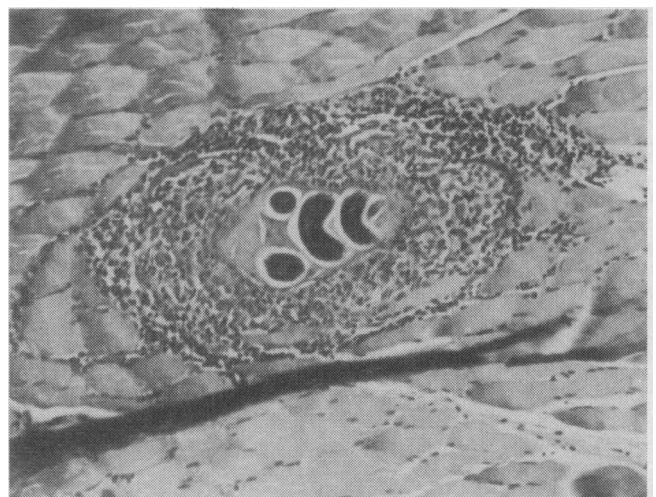


FIG. 2—Encysted larva of *T. spiralis* in section of human deltoid muscle (PAS, original magnification x 100).

Table I
Clinical features of 17 patients,
trichinosis outbreak,
British Columbia, 1971

Signs and symptoms	Number	Percent
Myalgia	17	100
Fever	14	82
Diarrhea	13	76
Fatigue	11	65
Periorbital edema	8	47
Abdominal cramps	6	35
Visual disturbances	6	35
Nausea, vomiting	5	29
Skin lesions	3	18
Dyspnea	2	12

Table II
Results of skin tests and laboratory findings of 17 patients,
trichinosis outbreak, British Columbia, 1971

Case	Skin test	Leukocyte count	Eosinophils (%)	Date	P*	AG†	BF‡
1	15 Nov Pos	2 Nov 16,350	2 Nov 55	15 Nov	Pos	8	Neg
				7 Dec	Pos	8	40
2	15 Nov Pos	9 Nov 13,150	9 Nov 31	15 Nov	Pos	4	Neg
				7 Dec	Pos	4	40
3	17 Nov Pos			17 Nov	Pos	Pos¶	10
				9 Dec	Pos	Pos¶	5
4	17 Nov Pos			17 Nov	Pos	128	80
5	17 Nov Pos			17 Nov	Pos	64	160
6	17 Nov Pos			17 Nov	Pos	128	320
				9 Dec	Pos	8	80
7	9 Dec Pos			9 Dec	Pos	32	320
8	9 Dec Pos			9 Dec	Pos	64	5120
9		5 Nov 8,200	5 Nov 45	20 Nov	Pos	64	10
				11 Jan			160
10		27 Nov 11,760	1 Nov 36	15 Jan	Pos	4	40
				17 Feb	Pos	4	20
11							
12	8 Dec Pos	8 Nov 10,400	29 Nov 42	8 Dec	Pos	16	320
				4 Jan	Pos	16	160
13	19 Nov Pos	15 Nov 14,900	15 Nov 50	19 Nov	Pos	4	80
14	19 Nov Pos	15 Nov 23,250	15 Nov 51	12 Nov	Pos	2	
				19 Nov	Pos	4	80
15	10 Dec Pos	14 Nov 23,100	14 Nov 52	23 Nov	Pos	64	160
				29 Nov	Pos	64	1280
16	10 Dec Pos	15 Nov 11,400	15 Nov 32	21 Nov	Pos	8	80
				4 Jan	Neg	16	640
17	23 Nov Neg	15 Nov 16,800	16 Nov 44	22 Nov	Pos	8	80

*Precipitation test

†Reciprocal of dilution giving standard agglutination

‡Reciprocal of dilution giving standard bentonite flocculation

¶Weakly reactive

ranged from three to 24 (mean 14.4) days; the illness lasted from a few days to six or eight weeks. In some patients recovery extended into the third month. The age of the patients varied from 22 to 69 years; 10 were male and seven female. Seven patients were hospitalized. There were no deaths.

Only two patients received anthelmintic treatment with thiabendazole (Mintezol®). In one patient the benefit conferred by this treatment was only slight. The other, on the third day of medication (1 g. twice daily), had a severe exacerbation with vomiting, general malaise, loose bowel movements, pain and numbness in the right cheek, general muscle pains,

extreme fatigue and depression. Some of these symptoms could have been the effects of thiabendazole.

Laboratory findings

Patients: Results of skin tests and laboratory findings are shown in Table II. In response to skin tests, using a 1:10,000 solution of trichinella extract, induration ranged from 8 to 14 mm. in diameter and redness from 30 to 85 mm. The test was considered positive when induration and redness extended beyond the injection bleb. Marked increases in bentonite flocculation titres were found in five patients. The hemagglutination test was reactive in only four of 16 patients. Eosinophil counts were high in 10 patients. Muscle biopsy was performed on four patients; three (#1, 15, 17) revealed larvae of *T. spiralis*.

Meat: In November 1971 bear meat and sausage samples examined by the compressorium technique¹³ were found to contain non-viable larvae of *T. spiralis*. Larvae were seen in samples of smoked sausage taken from the home of the two Castlegar women (#1, 2), in a sample of salami (Fig. 3) obtained from patient #8, in remnants of bear meat eaten by the Chilliwack couple and their son-in-law (#9, 10, 12) and in remnants of bear meat (Fig. 4) eaten by one of the Kelowna men (#17).

In bear muscle, trichinae appeared as coiled larvae within thick-walled cysts (Fig. 4). The concentration of larvae per gram ranged from 12 in smoked sausage to 150 in salami to 575 in bear meat. To make inspection of the blended meat products for trichinae more sensitive, individual fragments of each sample were separated on the basis of colour and consistency and examined by the digest compressorium technique.¹³ To identify the animal species in such meat, the balance of each trichinous sample was sent for serological examination to the Crime Laboratory. The smoked sausage was found to contain meat of deer family and pig family origin; the salami, of bear family and pig family origin.

Epidemic measures

Public Health inspectors seized suspect meat and ordered the innkeeper to cease serving such meat to the public. Health officials warned the public by newspaper and radio of the danger of eating pork or bear meat

that had not been heated to a minimum of 65.5°C. in all parts of the meat, or meat that had not been refrigerated at minus 27°C. for a minimum of 36 hours.¹⁴ More recently Clark and his colleagues⁶ have pointed out that current recommendations for inactivating porcine trichinae through storage at cold temperatures may not be lethal to ursine trichinae.

Discussion

The reservoir of ursine trichinosis in British Columbia is not known. Bears readily acquire infection by eating, at poorly maintained garbage dumps, discarded bear remnants, rats or, where porcine trichinosis is endemic, pork remnants. A fourth possibility is that bears are infected from some undisclosed sylvatic source. A 1949 study of trichinosis in British Columbia revealed larvae of *T. spiralis* in the diaphragms of 9.8% of 82 rats trapped at five garbage dumps.¹⁵ A recent study in the northwestern United States showed that the prevalence of trichinosis in black bears lies between 0.15 and 2.5% and is four times greater than in garbage-fed swine.¹⁶ In a study of 2433 Alaskan mammals, trichina larvae were found in 52.9% of polar bears, in 50% of grizzly bears and in 21.7% of black bears; trichinae were also found in seven rodent species, important sources of food for carnivorous mammals.¹⁷ *T. spiralis* is probably a natural parasite of bears, commonly occurring in remote areas as well as in the vicinity of human habitations.¹⁸

During the present investigation the Crime Laboratory detected bear meat as well as pork in the trichinous salami and deer meat as well as pork in the trichinous smoked sausage. Failure to prove serologically that the trichinous smoked sausage contained bear meat could have been owing to either denaturation of the bear meat during processing or, more likely, to the small amount of bear meat introduced into the sausage. From the larva counts it was calculated that no more than 2% of bear meat had been added to the sausage mix. This degree of adulteration could have been caused inadvertently by contamination of the meat grinder — another potential hazard of processing game meat in plants normally used only for handling commercial meat.

The investigation of this outbreak

was complicated by the wide geographical distribution of cases originating from a common source. With fast modern travel patients may reach distant places by the time symptoms appear. Trichinosis must be included in the differential diagnosis of prolonged febrile illness with a history of eating undercooked meat and prominent clinical features such as myalgia, eosinophilia and edema, often periorbital.

Precipitation, agglutination and bentonite flocculation tests were found to be useful diagnostic tools. The bentonite flocculation test detects antibodies after the third week of infection; titres rise rapidly for several weeks until a peak is reached and then drop slowly; almost all persons have negative test results after two or three years and titres of 1:5 are considered diagnostic.¹⁹ This investigation confirms the observation^{8, 20, 21} that the bentonite flocculation test is a highly specific serological test for detecting acute trichinosis. The diagnostic value of the hemagglutination test is questionable; in our series sera from only four of 16 patients gave reactive results.

The public should be made aware of the danger of eating inadequately cooked bear meat and of leaving raw bear meat unburied at garbage dumps or in the woods. Perhaps a warning, pointing out the danger of trichinosis from bears, could be attached to hunting licences.¹⁶ Infected bears have been shot near open garbage dumps.⁸ Public Health authorities should therefore stress the need for frequent covering of solid waste disposal sites and adequate fencing to exclude scavenging animals.^{7, 16}

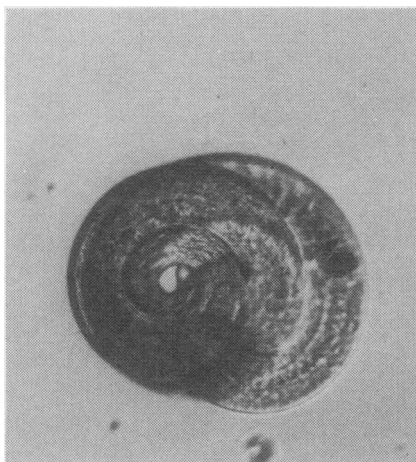


FIG. 3—Photomicrograph of larva of *T. spiralis* (original magnification x 40) collected from the digest fluid of salami sausage.

The recognition, tracing and control of this outbreak was made possible by the concerted efforts of practising physicians, medical health officers, veterinarians and laboratory specialists, using an effective system of prompt intercommunication.

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Summary

In British Columbia in 1971, 17 persons contracted ursine trichinosis after eating inadequately smoked black bear (*Euarctos americanus*) meat or adulterated commercial pork products. After incubation periods of three to 24 (mean 14) days pa-



FIG. 4—Encysted larva of *T. spiralis* in section of smoked bear muscle (PAS, original magnification x 100).

tients developed myalgia, fever, diarrhea and fatigue; some had peri-orbital edema, abdominal cramps, visual disturbances, nausea or vomiting, skin lesions or dyspnea. The length of the illness was from a few days to more than two months; recovery was often protracted. Seven patients were admitted to hospital but none died.

Résumé

Trichinose provoquée par ingestion de viande d'ours et de produits à base de viande de porc avariée: épidémie majeure en Colombie Britannique en 1971

En 1971, 17 personnes résidant en Colombie Britannique ont contracté la trichinose après avoir mangé de la viande d'ours noir (*Euarctos americanus*) insuffisamment fumée ou des produits à base de porc avariée. Après une période d'incubation variant de trois à 24 jours (moyenne de 14 jours) les malades présentaient de la myalgie, de la fièvre, de la diarrhée et de la fatigue; certains avaient un oedème périorbitaire, des coliques abdominales, des troubles visuels, de la nausée et des vomissements, des lésions cutanées ou de la dyspnée. La maladie a duré de quelques jours à plus de deux mois chez certains. La guérison a été souvent lente à se produire. Sept malades ont dû être hospitalisés, mais aucun décès n'a été enregistré.

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Surgical treatment of abdominal aortic aneurysms in Toronto: a study of 1013 patients

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The experience of surgeons at three Toronto hospitals in the treatment of 1013 abdominal aortic aneurysms from 1955 to 1971 is presented.

In the first 10 years the average interhospital mortality rate for elective and ruptured aneurysms was 11.2%, in the second five years it was 9.8% and in the last two years it was 6.7%. In these three periods the percentage of ruptured aneurysms fell from 34 to 22% but the probability of survival following operation for a ruptured aneurysm remained stationary at 33%. On the other hand,

the mortality rate for elective resection of abdominal aneurysms declined from 11.25% in the first period to 6.7% in the last two years.

Risk of operation is increased in patients who are very old or who have associated coronary or generalized atherosclerosis. The present policy in Toronto is to recommend elective resection in any patient with a demonstrable aneurysm who appears to have a life expectancy of at least two years.

"There are two different kinds of aneurysms. The one occurs when there is local dilatation of an artery. The other kind arises from the rupture of an artery and the discharge of blood into the flesh beneath it. . . . It is foolish to follow the practice of the ancient surgeons and decline to treat any aneurysm but it is dangerous to apply surgical treatment to all types. . . . Those who tie the artery as I advise, at each extremity, but amputate the intervening dilated part, perform a dangerous operation. The violent tension of the arterial pnuma often displaces the ligatures." (from the

Presented to the Canadian Cardiovascular Society at the annual meeting, October 21, 1972, at Toronto.

*The Interhospital Cardiovascular Surgery Group of the University of Toronto consists of the staff cardiovascular surgeons at all the teaching hospitals. For this initial study the surgeons at St. Michael's Hospital, the Toronto General Hospital and the Toronto Western Hospital have contributed the data. The coordinators of this study were Drs. R. J. Baird, J. A. Key, and J. Yao.

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