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HYDATID INFECTION IN CANADA*

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HUMAN HYDATID CYST infections are generally thought to be of rare occurrence in Canada and any such infections are usually considered of foreign origin. Nevertheless, a few cases are on record which could not be attributed to a source outside this country and until recently there has been no adequate explanation for their occurrence. It is true that for many years hydatid cysts have been seen sporadically in domestic animals and, more recently, hydatid infections are being diagnosed with increasing frequency in wild herbivora, notably moose and caribou. The fact that wolves are infected with the tapeworm, *Echinococcus granulosus,* the eggs of which, when passed out and ingested by herbivora and man, develop into hydatid cysts, indicates that this disease is endemic in Canadian wildlife.

The question of autochthonous human hydatid infections in this country was brought into sharp focus when the Indian Health Service discovered that hydatid infections were showing up with relative frequency in the Indian population of northwest Canada. Accordingly, at the request and with the assistance of the Indian Health Service and the Laboratory of Hygiene, Department of National Health and Welfare, a survey was carried out in the summer of 1952 to investigate the source and prevalence of hydatid disease in Indians and to determine, if possible, methods of control.

For purposes of the investigation a tour was made of Indian Reservations in British Columbia, Alberta, and the Northwest Territories; 28 villages were visited. At every village, dogs were collected for autopsy studies and examined for the presence of *E. granulosus* in an endeavour to discover a source of the human infections. In addition, skin tests for the Casoni reaction were carried out on the natives at a number of villages in order to determine the prevalence of infection and to check the efficiency of the antigen. Wherever and whenever possible, discussions were held with Indians, trappers, game wardens and Provincial and Federal biologists, to obtain information on:

(a) Native customs and habits with especial emphasis on the rôle of game animals in the economy of the villagers.
(b) The prevalence and feeding habits of wild herbivora and carnivora in the various areas visited.
(c) The prevalence of hydatid infection in the wild herbivora and of *E. granulosus* in wild carnivora.

Indian hospitals and other institutions concerned with x-ray surveys and medical care of Indians and Eskimos were visited and all available films of diagnosed or suspected hydatid cyst cases were reviewed. In addition, several thousand chest plates of Indians from known endemic areas were checked for the presence of calcified hydatid cysts of the liver. Further information was obtained by means of a questionnaire regarding cases of hydatid disease occurring in hospitals throughout Canada.

RESULTS

1. SYLVATIC ECHINOCOCCOSIS

This term refers to the parasitic life cycle in wild animals involving the hydatid tapeworm, *Echinococcus granulosus,* and its larval stage the hydatid cyst. In Canada, the wild carnivora acting as the definitive hosts for the adult tapeworm are probably the wolf, the coyote, and the fox. De Vos and Allin[1] report this tapeworm as the most common found in wolves in Ontario. Cowan,[2] and James Hatter,[3] Provincial Biologist, British Columbia, have recorded it from wolves in Alberta, and Sweatman[4] found 36 of 58 wolves from Ontario infected. Riley[5] has shown that 50% of the wolves harbour *E. granulosus* in certain parts of Minnesota. During the course of this study a coyote *(Canis latrans),* shot near Anahim Lake, B.C., was found positive for *E.*

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granulosus and as this was the only coyote examined, it is possible that the infection is not uncommon in this host in some areas. Sweatman[4] reports *E. granulosus* from one coyote and one fisher *(Martes pennanti)* from Ontario. A single Arctic fox *(Alopex lagopus)* examined at Fort Smith, N.W.T., during this survey was negative

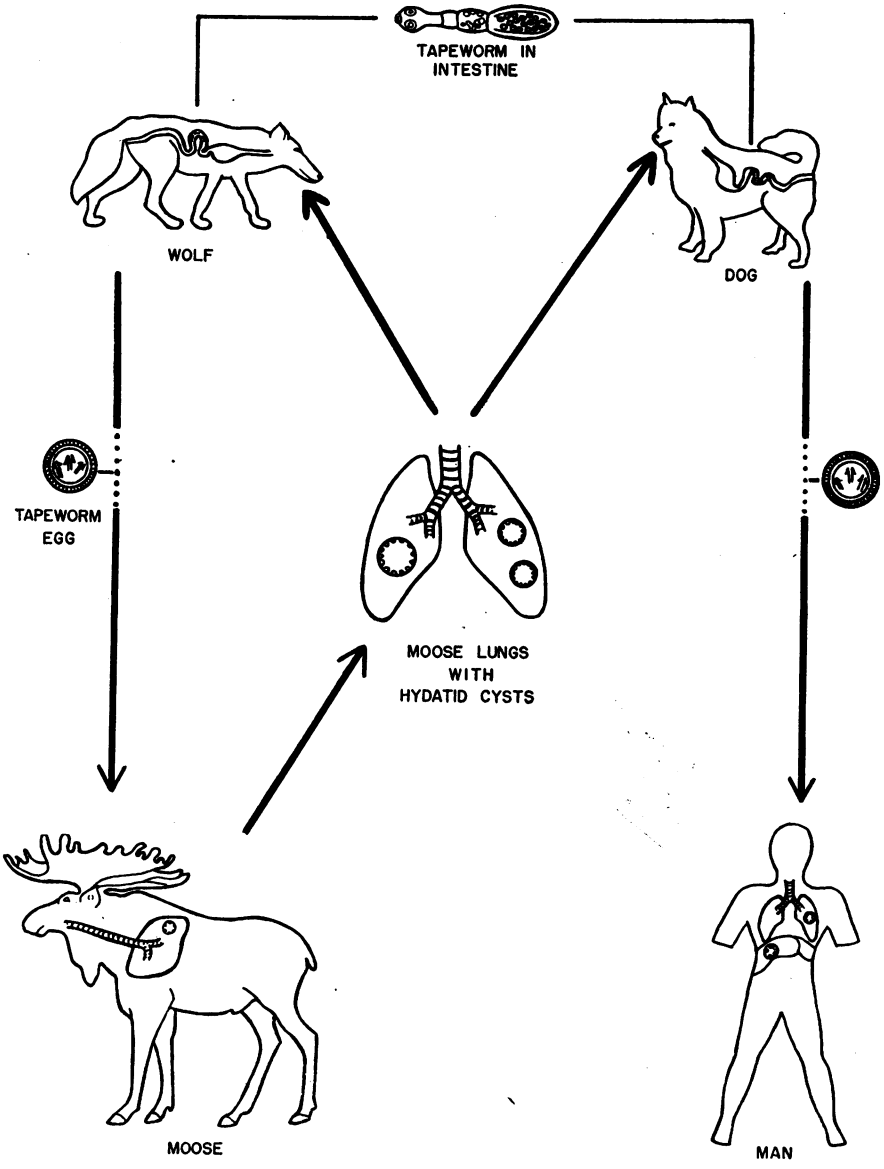


Diagram 1.—Schematic representation of *E. granulosus* life history in sylvatic echinococcosis, and the epidemiology of human hydatidosis in Canada.

for parasites but Rausch and Schiller[6] report *E. granulosus* in the Arctic fox from Laurence Island, Alaska, and Choquette[7] has found it in Arctic fox from Bank's Island, N.W.T.

The wolf is undoubtedly the important definitive host for *E. granulosus* among wild carnivora and it is unlikely that a sylvatic echinococcosis could be set up in the absence of wolves unless it is found that there is a carnivore-rodent cycle in existence, in which the rodent replaces the herbivore as the host for the hydatid cyst, as suggested by the findings of Rausch and Schiller[6] in Alaska. Although it is known that coyotes can and occasionally do pull down a large herbivore such as the moose, particularly if the animal is on ice or is injured, it is believed that both the coyote and the fox usually acquire their infections when acting as scavengers. The importance of the wolf in maintaining the cycle in nature is suggested by the situation existing in Newfoundland where, according to

Choquette,[7] the examination of large numbers of moose has never revealed hydatid infection; while foxes are common in Newfoundland, no wolves are found at present.

The wolf acquires an *E. granulosus* infection by ingesting the hydatid cyst present in the lungs of his herbivore prey. The herbivore, in turn, becomes infected by ingesting accidentally eggs of *E. granulosus* which have fallen to the ground in the excreta of the wolf (Diagram 1). Practically all species of wild herbivore in Canada have been found infected with hydatid cysts which, with rare exceptions, localize in the lungs of these hosts. Hydatid cysts have been reported from moose *(Alces americana)*, Barren ground caribou *(Rangifer arcticus)*, wapiti or elk *(Cervus canadensis)*, reindeer *(Rangifer tarandus)*, coast deer *(Odocoilens Hemionus columbianus)*, white-tailed deer *(O. virginianus)* and the bison *(Bison bison)*.*

Although it would appear that all the wild herbivores are susceptible to infection and do acquire it, there is no doubt that in sylvatic echinococcosis in Canada, the important herbivores acting as intermediate hosts for the hydatid cyst stage are the moose and Barren Ground caribou.

Moose infected with hydatid cysts have been recorded from every province west of the Maritimes; in Ontario and British Columbia, where the most extensive studies have been made, it is estimated that about 50% of the moose are infected (Hatter,[3] Sweatman[4]). In much of the Northwest Territories and northern Alberta, Saskatchewan and Manitoba, the Barren Ground caribou takes over the rôle as the intermediate host for hydatid cysts. There is not sufficient information available at this time to estimate the incidence of infection in this host but from information supplied by W. Fuller, Mammalogist, Wood Buffalo Park, N.W.T., it would appear to be between 5 and 20%.

2. Dog Infections with Echinococcus Granulosus

A total of 114 dogs were obtained for study and the number from each village together with those found positive are shown in Table I. This table shows that of the 114 dogs autopsied, 32, or 28%, were positive for *E. granulosus*. If these figures are broken down to districts, it is seen that the incidence of dog infections in the "Carriere" group of Indians in the Stuart and Babine-Lakes area is well over 50%, whereas the dogs of the Northwest Territories Bands of Dog Ribs, Chipewyans and Crees show an infection rate of about 10 to 15%.

The hydatid tapeworms were found throughout the length of the small intestine in the infected dogs but were usually concentrated in the upper part of the jejunum. In each of two animals only a single worm was found, and in several others very few were recovered. However, most of the infected animals harboured hundreds of *E. granulosus* tapeworms and in a good percentage they were present in the thousands.

TABLE I.

INCIDENCE OF INFECTION WITH E. GRANULOSUS IN DOGS

Region	*No. Examined*	*No. Positive*
Fort St. James, B.C.	4	1
Tachi, B.C.	5	2
Trembleur, B.C.	1	1
Portage, B.C.	2	1
Pinchi, B.C.	1	1
Takla, B.C.	6	4
Fort McLeod, B.C.	3	2
Babine, B.C.	11	6
Stelaco, B.C.	3	2
Fort Fraser, B.C.	2	0
Kispiox, B.C.	7	2
Kitwanga, B.C.	2	0
Kitwancool, B.C.	2	0
Port Simpson, B.C.	2	0
Anaham, B.C.	5	0
Anahim Lake, B.C.	4	2
Fort Nelson, B.C.	12	1
Yellowknife, N.W.T.	3	1
Gros Cap, N.W.T.	3	0
Fort Rae, N.W.T.	6	1
Lac La Martre, N.W.T.	2	0
Fort Chipewyan, N.W.T.	8	0
Hay Lake, Alta.	2	2
Hay River, Alta.	1	0
Fort Providence, N.W.T.	3	1
Fort Resolution, N.W.T.	2	0
Fort Smith, N.W.T.	6	1
Fitzgerald, Alta.	6	1
Total	114	32

The presence of large numbers of infected native dogs seeding their environment with millions of hydatid tapeworm ova leaves no doubt as to the source of hydatid disease in the Indians.

The dog is of prime importance as a means of transportation to the Indian population in northern Canada. In northern and central British Columbia, dogs are used either as pack animals

*According to Sweatman,[4] a hydatid cyst was reported in one out of 216 bison by Cameron (1923). That this infection is rare in bison is further suggested by the findings of Fuller,[8] who never recovered a hydatid cyst in a careful examination of several hundred bison, although infected caribou occur in the same range.

or as sled dogs. Farther south, in the Chilkotan country, where horses replace dogs for transportation, dogs are still present in large numbers and are used for hunting or kept as pets. In the Northwest Territories, dogs are especially valued as sled dogs and play an important part in the economy of the community. Food for dogs is a great problem and in those areas where fish is not available or is in short supply, the Indian must depend on the wild herbivore even though this is illegal. In any case, the lungs are rarely if ever eaten by Indians and it is common practice in central and northern British Columbia to feel moose lungs to the dogs together with other entrails.

It is not unusual for Indians to shoot several moose when following a trap-line and in these cases the dogs are invariably fed the viscera along with other parts of the animal. When animals are shot close to the village, the viscera are left at the site of the kill and are readily accessible to the dogs.

There always appear to be large numbers of dogs attached to Indian villages irrespective of their usefulness. However, the number of dogs does not necessarily play a decisive rôle in the incidence of infection with *E. granulosus*. The factors listed below determine the infection rate in dogs and hence indirectly, the human infection rate with hydatid cysts.

1. The coexistence of moose or caribou, and wolves in the area.
2. The prevalence of moose or caribou in an area.
3. The extent to which moose or caribou plays a part in the economy of the community either as human food, as dog food, or as a source of buckskin, etc.
4. The extent to which dogs are used in the economy of the natives.
5. The importance of trapping for fur-bearing animals as a source of revenue.
6. The level of prosperity in a community.

For example, in the Stuart Lake Agency, B.C., moose are plentiful and are killed in large numbers for human and dog food as well as for their hides, which command a good price. Dogs are used extensively as pack animals or sled dogs. The Indians depend to a large extent on trapping for their livelihood and they are far from prosperous. Accordingly, the dogs in these areas show the highest infection rate seen anywhere. At Fort Nelson, B.C., even though fur is the chief source of income and dog teams are used extensively, the infection rate in dogs is not high because of the scarcity of moose and the relative prosperity of this community. Some of these Indians have been buying and feeding canned salmon to their dogs! In the Hazelton area, B.C., moose are numerous but many of the Indians derive their livelihood from fishing in the Skeena River or working in canning factories at Prince Rupert. Trapping plays a minor rôle as a source of income and consequently the infection rate in dogs is not high. In central British Columbia, moose are very numerous, but the main source of revenue comes from ranching. Dogs acquire the infection only when moose are shot close to the villages or at hay camps and the viscera are accessible. Infected dogs were found but the infection rate is not high.

In much of the Northwest Territories, northern Alberta, Saskatchewan and Manitoba, trapping is the chief source of revenue and the caribou plays a vital rôle in the economy of these people. However, there is a belief by the Crees, Chipewyans and Dog Ribs that lungs, when fed to dogs, tend to "cut off their wind", and many Indians will not feed lungs to their dogs except on those occasions when there is a shortage of food. These facts probably explain the lower incidence of infection in dogs belonging to these Indians. The Slave Band around Hay Lakes who are moose hunters, and depend on trapping for their livelihood, do not have this taboo against

TABLE II.

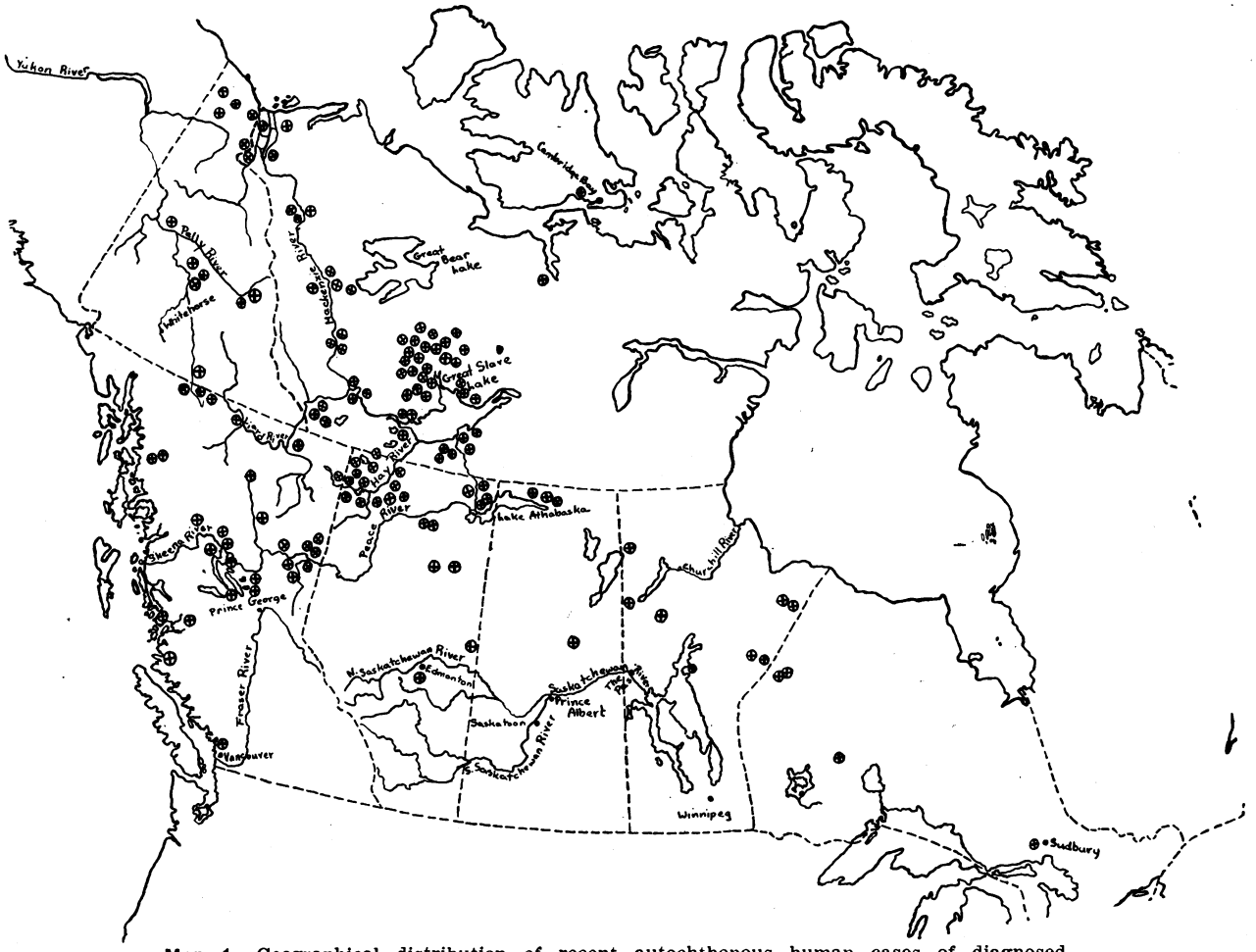
HYDATID INFECTIONS GROUPED ACCORDING TO AGE AND SEX

Age in years	*Infected males*	*Infected females*	*Total No. infected*	*Percentage infected*	*Percentage of total population (1949 census)*
Under 7	2	2	4	3	22
7 and under 16	14	20	34	24	21
16 and under 21	7	5	12	9	11
21 and under 70	34	40	75	53	43
70 and over	9	8	17	11	3
Total	55	75	141	100	100

lung feeding, and consequently show a high infection rate in their dogs.

While the number of dogs does not have a direct bearing on the incidence of hydatid disease there is no doubt that a reduction in dog population by destroying ownerless and useless dogs would have value. Ownerless dogs must live as scavengers and would be the first to feed on viscera of animals shot close to villages. In the Chilkotan district of British Columbia, the only two dogs found infected were of this type.

and Ontario. Three cases are in Eskimos, 136 in Indians, and the remaining two cases in whites. The youngest infected patient is a child of 2.5 years of age, while the oldest infection is in a woman of 83 years. Table II gives the distribution of hydatid infections according to age and sex. As can be seen from the table, infections occur with approximately the same frequency in both sexes. When calculated on the basis of age-grouping distribution in the Indian population, based on the 1949 census, the incidence



Map 1.—Geographical distribution of recent autochthonous human cases of diagnosed hydatid disease occurring in Canada.

⊠—represents one case.

3. HUMAN CASES OF HYDATID CYST INFECTION

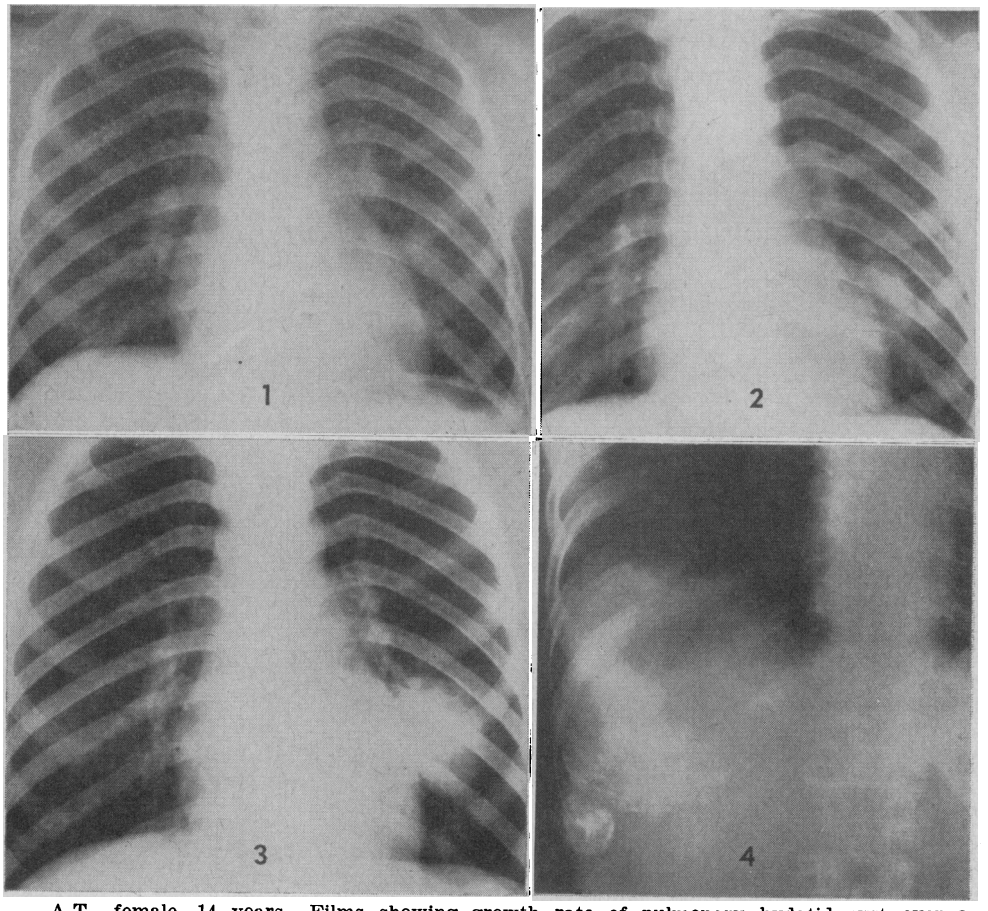
Information, based on hospital records and x-ray films, has been collected on 141 patients with proved or suspected recent* autochthonous hydatid disease, of which over 90% are in northern British Columbia and Alberta, the Yukon and the Northwest Territories. The remaining cases occur in Saskatchewan, Manitoba

of infection in the 7 to 15 year, the 16 to 20 year, and the 21 to 69 year groups is roughly the same; children under 7 years show a much lower incidence of infection than that shown by the other age groups, whereas the "over 70" age group shows triple the infection rate.

The geographical distribution of the cases is shown on Map 1. In 97 of the cases, the cysts are in the lungs and in the remaining 44, in the liver. Of the 141 cases, 28 have been proved at surgery or post-mortem examination.

*Diagnosed within the past five years.

One cannot, of course, be certain that the cases diagnosed by x-ray findings alone are all hydatid cysts. However, the characteristic rounded shadow of hydatid cyst in the lung is quite readily identifiable, particularly if plates made on successive years are studied, showing the gradual increase in size (Figs. 1 to 3). The calcified shadows seen in the liver are most likely of hydatid origin. There is very little else that will give this finding on an x-ray plate, and found elsewhere in the body has been variously estimated as 1:10 to 1:3. If we take the lowest figure we find that if 97 lung cysts occur in the group under study, there must be at least an additional 291 patients and probably many more with hydatid cysts elsewhere in the body. That they are not rare in the liver, we have been able to prove by demonstrating liver cysts in x-ray plates. It must be appreciated that only cysts with calcium deposits can be visualized; further-



A.T., female, 14 years.—Films showing growth rate of pulmonary hydatid cyst over a two-year period. **Fig. 1.**—X-ray film 1949—cyst (2.3 x 1.3 cm.) left lung. **Fig. 2.**—X-ray film 1950—cyst (3.2 x 2.2 cm.) has increased in size. **Fig. 3.**—X-ray film 1951—cyst (4.0 x 5.5 cm.) shows further growth.

J.T., female, 70 years.—Film showing hydatid cyst in liver. **Fig. 4.**—X-ray film 1952—two cysts can be seen in the liver; the large cyst (11.5 cm.) is pushing up the right diaphragm, the small cyst (3.0 cm.) is heavily calcified and probably non-viable.

several have been proved by laparotomy (Fig. 4).

One can, therefore, be reasonably sure that at least 90% or more of these suspected cases of hydatid disease are indeed hydatid infection.

The localization of hydatid cyst in the human host follows a fairly definite pattern: the liver invariably shows the highest incidence of localization, with the lung being the second most commonly infected organ; the small remaining percentage localizes elsewhere in the body. The ratio of cysts localizing in the lungs to those more, they must be high enough in the liver to be included in a chest film, and finally the film must be somewhat over-exposed to show the presence of the cyst. If, with all these qualifications, it was possible to spot about 40 calcified cysts on checking through the survey chest films, it is most probable that hydatid cysts of the liver in this group are fairly common.

Skin tests for hydatid disease (Casoni reaction).—The antigen used in performing skin tests was sterile hydatid fluid. It was collected in

Australia from hydatid cysts in domestic animals. Only those reactions showing a wheal measuring at least 2.2 cm. were considered positive; reactions showing a wheal of 1.8 to 2.2 cm. were read as doubtful and those with a wheal of less than 1.8 cm. were classed as negative. The erythema was not considered significant. All reactions were controlled by an intradermal injection of saline.

The areas tested and results obtained are shown in Table III, where, of 842 persons tested, 15 were positive and 12 gave a doubtful reaction.

Ten patients who had lobectomies for hydatid cysts or who gave excellent radiological evidence of hydatid cysts, were tested, and only four, or less than 50%, showed a positive reaction. With

TABLE III.

RESULTS OF SKIN TESTS FOR HYDATID DISEASE

Region	*No. tested*	*No. positive*	*Doubtful positive*
Lejac School, B.C.	99	1	4
Fort Fraser, B.C.	24	0	0
Stelaco, B.C.	19	0	1
Fort St. James, B.C.	79	3	1
Fort McLeod, B.C.	34	0	0
Portage, B.C.	10	0	1
Tachi, B.C.	42	3	1
Takla, B.C.	41	2	0
Fort Babine, B.C.	98	5	3
Miller Bay Hospital, B.C.	26	0	0
Kispiox, B.C.	42	1	0
Kitwancool, B.C.	27	0	0
Kitwanga, B.C.	14	0	0
Grand Rapids, B.C.	3	0	1
Fort Nelson, B.C.	55	0	0
Fort Rae, N.W.T.	229	0	0
Total	842	15	12

one exception, all reactions were of the immediate type and were well established at ten minutes. The second reading at 30 minutes showed a regression of the wheal in most cases and by one hour, all reactions were subsiding. About 200 cases were checked at 10-hour and 24-hour intervals but no further reactions developed. As stated above, only one case showed a delayed reaction which appeared six hours after the test.

That the antigen showed some specificity is suggested by the higher number of positive reactions found in villages in British Columbia where the greatest percentage of dogs were found infected, *e.g.*, Fort Babine, Takla, and Tachi Reserves. On the other hand, it is hard to explain the consistently negative results at Fort Rae in the Northwest Territories, where a relatively high incidence of hydatid infection is known to exist. The antigen from the same source was used in all cases, although the antigen was one month older when used in the Northwest Territories and this latter fact may account for the apparent loss of activity in the antigen.

It has been reported that false positive reactions with hydatid antigen occur in tuberculosis. Our experience with about 30 known tuberculosis cases has not confirmed this finding although it would be necessary to study a larger group before a definite opinion on this problem could be formed. It is of considerable practical importance because of the confusion of tuberculoma with hydatid cyst, and also because pleurisy can be of hydatid origin.

Eosinophilia in hydatid disease.—Blood smears were made from 25 individuals showing a positive or doubtful skin reaction. The smears were stained and a differential white-blood-cell count made on each. Four of the 25 showed the eosinophils in above average numbers with the following percentages: 20, 12.5, 9 and 7. The remaining 21 cases showed eosinophil counts of 5% or less. From these limited results and the fact that these cases were not proved hydatid infections, no conclusion can be drawn regarding the significance of eosinophilia as an aid in diagnosing hydatid disease. From information obtained at the Charles Camsell Indian Hospital, however, where known positive cases of hydatid infection have been studied, it would not appear that a raised eosinophilia count is characteristic of this infection.

Infection rate.—An accurate estimate of the infection rate with hydatid cysts in the native population cannot yet be made. The total number of cases diagnosed gives relatively little information in this regard because the majority of cases, that is, those with extra-pulmonary cysts, cannot be diagnosed unless the cysts are old and calcified or they come to surgery or autopsy. Furthermore, some Bands will show a high infection rate while others are free of infection. The Indians at Fort Rae show the highest rate found anywhere and here a total of 21 cases have been found; 12 of these harbour lung cysts and 9 calcified liver cysts. If one estimates that there are three extra-pulmonary cysts for every lung cyst, and this undoubtedly is an underestimate, one arrives at a figure of 36 plus 12, or a total of at least 48 cases in a population group

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of 740. This gives an infection rate of 65 cases per thousand.

The infection rate in the Slave Band at Hay Lakes is also high and probably equals the infection rate seen at Fort Rae. The infection rate in north-central British Columbia can only be estimated on the basis of the skin tests, the reliability of which at this time is not well known and, in the author's opinion, probably gives an under-estimation of the true rate. If the figures for the Fort Babine, Takla, and Tachi Bands are taken (Table III), it is found that of 181 persons tested, 10 gave positive reactions, giving an infection rate of 55 cases per thousand.

In spite of the higher incidence of hydatid tapeworm in dogs in British Columbia, the number of cases of human hydatid infection reported from British Columbia is lower than that found in the Northwest Territories. This is probably due to the fact that the disease is of recent origin in British Columbia; according to Hatter,[3] wolves and moose have only recently invaded most of this province. Additional evidence is the fact that not a single calcified liver cyst was found on review of practically all chest films of Indians from north-central British Columbia available at Miller Bay Hospital. It can be anticipated that a rapid rise in the number of human hydatid cases will occur in these areas if no preventive measures are taken.

Hydatid infection in the white population.— Only two cases of autochthonous hydatid infection were encountered in the white population. One was in a white settler who had lived in northern British Columbia for many years, and the other in a schoolboy of 14 years, who had lived most of his life in Vancouver. White trappers can acquire the infection from their sled dogs in the same manner as do the Indians. Another source of infection to the white population could be the initiation of a cycle involving domestic animals and farm dogs. At the present time, available information on the incidence of hydatid cyst infections in domestic animals in British Columbia and Alberta is inadequate. The finding of dogs infected with *E. granulosus* in such areas as Prince George and in the Chilkotan district of British Columbia indicates that livestock must inevitably become infected. Infection in the livestock could easily set up a cycle between domestic herbivores and dogs which would serve as a source of infection to the white farmer and rancher. Another possible source of infection is dogs infected with *E. granulosus* imported from endemic areas to urban centres, and it is believed that the Vancouver schoolboy acquired his infection in this manner.

RÉSUMÉ AND CONCLUSIONS

Stretching across northern Canada and dipping down to include most of British Columbia is a huge area supporting a rich fauna of wild herbivora and carnivora. The tapeworm, *Echinococcus granulosus,* is well-established in the carnivora, particularly in wolves which seed much of this area with tapeworm eggs. The eggs are picked up by the herbivora, usually moose or caribou in which the hydatid cyst develops. The completion of the cycle is assured when wolves kill and eat the flesh, including the infected lungs, of these hosts. This cycle among wild animals, which we have termed sylvatic echinococcosis, has probably existed in Canada for centuries and is of no economic consequence except for its possible effect on the well-being of the moose and caribou. Man rarely, if ever, acquires infection from the wild carnivora. However, when man infects his dogs by feeding them lungs of caribou and moose, he initiates a cycle in his immediate environment in which he inevitably plays the rôle of intermediate host. By soiling his hands with eggs of *E. granulosus* picked up from the ground contaminated by fæces, or from the soiled coat of the dog, or by ingesting eggs in contaminated drinking water, or, conceivably, by inhaling eggs, he becomes a host to the hydatid cyst (Diagram 1).

While man infects himself accidentally, our studies indicate that this accident happens with sufficient frequency among the Indians to constitute an important medical problem, both from the standpoint of prevention and treatment. And it is important that control measures be considered.

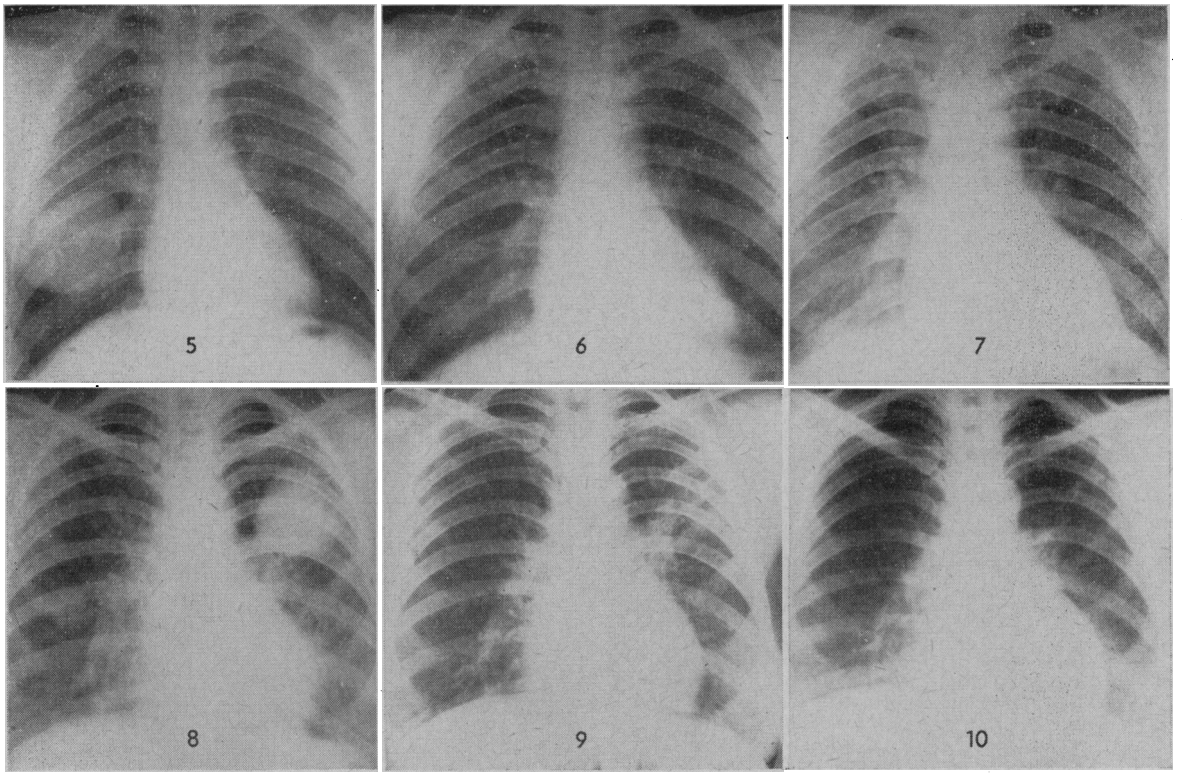
It is most probable that any attempt to control sylvatic echinococcosis would be unsuccessful and even impractical. We must assume that the wild herbivora will continue to harbour hydatid cysts and there is no practicable method of eradicating this infection, although such practices as wolf destruction by predator hunters help to reduce the prevalence of sylvatic echinococcosis.

The source of human hydatid infection is the dog infected with *E. granulosus* and control measures, to be effective, must have two chief

aims, namely: (1) protecting the dogs against acquiring infection, and (2) eradicating infection already present in dogs.

Accordingly, any control of this disease in natives will depend on Indian and Eskimo populations who are aware of the danger of feeding uncooked moose and caribou viscera to their dogs. Knowledge of this fact is the most important single factor in a control program. The Indians and Eskimos must be given this information in a simple yet effective manner and the best propaganda medium is probably a visual one such as a cinema, or if this is not possible, film strips. In addition, all Provincial and Federal employees working with Indians should be alerted to the presence of the disease and its method of control, and be instructed to introduce the topic at all meetings with Indians. As mentioned earlier, several of the tribes in the Northwest Territories already have a taboo against feeding lungs of caribou to their dogs which is partially effective and, with additional education, this could be made more effective.

At the present time, throughout north-western Canada there is a huge reservoir of *E. granulosus* infection in the existing dog population which constitutes a constant and ready source of hydatid infection to the Indian population. While these infections are self-terminated in from 6 to 20 months, the possibility of eradicating the infections with taeniacidal drugs should be considered. Treatment could be carried out by game wardens and/or Royal Canadian Mounted Police in the same manner as rabies vaccine is being administered to all dogs in the Northwest Territories. The tablets could be incorporated into bits of fat or meat and fed to the dogs. If this procedure proves practicable, it may be advisable to treat all dogs annually.



L.K., male, 26 years.—Films showing uncomplicated natural cure of pulmonary hydatid cyst. **Fig. 5.**—X-ray film 1947—cyst (9.0 x 6.5 cm.) right lung. **Fig. 6.**—X-ray film 1950—cyst has disappeared, presumably ruptured and coughed out. **Fig. 7.**—X-ray film 1952—no sign of cyst or residual lesion.

V.P., female, 33 years.—Films showing uncomplicated natural cure of pulmonary hydatid cyst. **Fig. 8.**—X-ray film 1949—cyst (6.0 x 8.0 cm.) left lung. **Fig. 9.**—X-ray film 1950—cyst has disappeared but discrete infiltration present. **Fig. 10.**—X-ray film 1951—no sign of cyst or residual lesion.

Regarding the disposition of the hydatid cases now known to be present, it should be pointed out that the prognosis in pulmonary hydatid infection may not be as bad as general medical opinion would indicate. Pulmonary cysts may, but rarely do, cause disease while living and growing. Eventually, they rupture into a bronchus* and are coughed up. At this stage there

*Rarely they burst into the pleural space.

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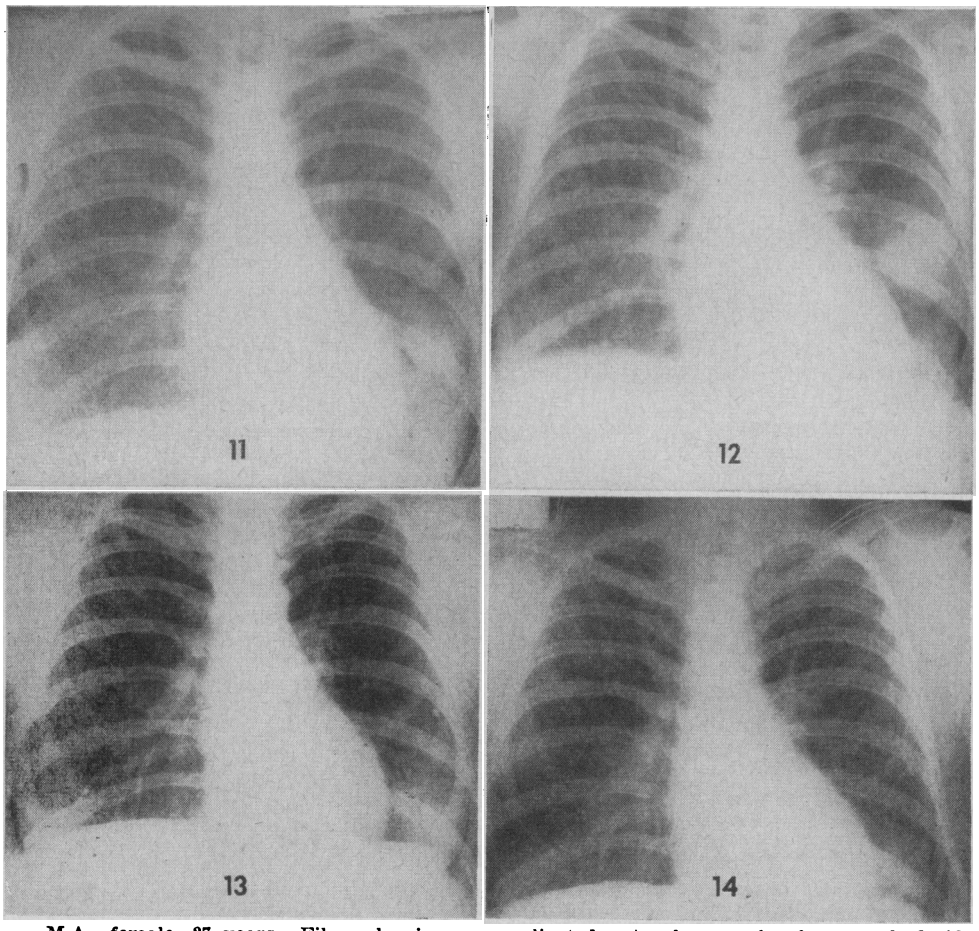
is normally a temporary illness which, however, may continue and develop into a serious chronic disease such as lung abscess. However, the majority of the cases probably effect a natural cure.

The visual history of five such cases is presented in x-ray films (Figs. 5 to 22). A study of these films shows that in the first three cases (Figs. 5 to 14) there was a natural cure without complications and with no residual damage to lung tissue. In the fourth case (Figs. 15 to 19) rupture of the cyst between 1949 and 1950 did not lead to its complete evacuation although some of the cyst contents were coughed out as evidenced by a reduction in the size of the cyst, that is, from 5.3 x 4.1 cm. to 3.5 x 3 cm. In 1951 (Fig. 18), the cyst shadow is further reduced and suggests fibrous changes. By 1952 (Fig. 19), the cyst has been completely evacuated and there is no evidence of important residual damage to lung tissue.

The fifth case (Figs. 20 to 22) was first seen in x-ray after it had ruptured and shows up in 1949 (Fig. 20) as a cystic structure with a fluid level; the possibility of secondary infection should be considered here although in the absence of a clinical history nothing definite can be known. In 1950 (Fig. 21) the cyst with a fluid level is still visualized but is reduced in size probably because of evacuation of part of the contents and re-expansion of lung tissue. By 1951 (Fig. 22), the cyst has been completely evacuated and there is no evidence of residual lung damage. We see, therefore, in cases 4 and 5, that in spite of complication due to incomplete evacuation of cysts when first ruptured, natural cure was still effected although it took a somewhat longer period of time.



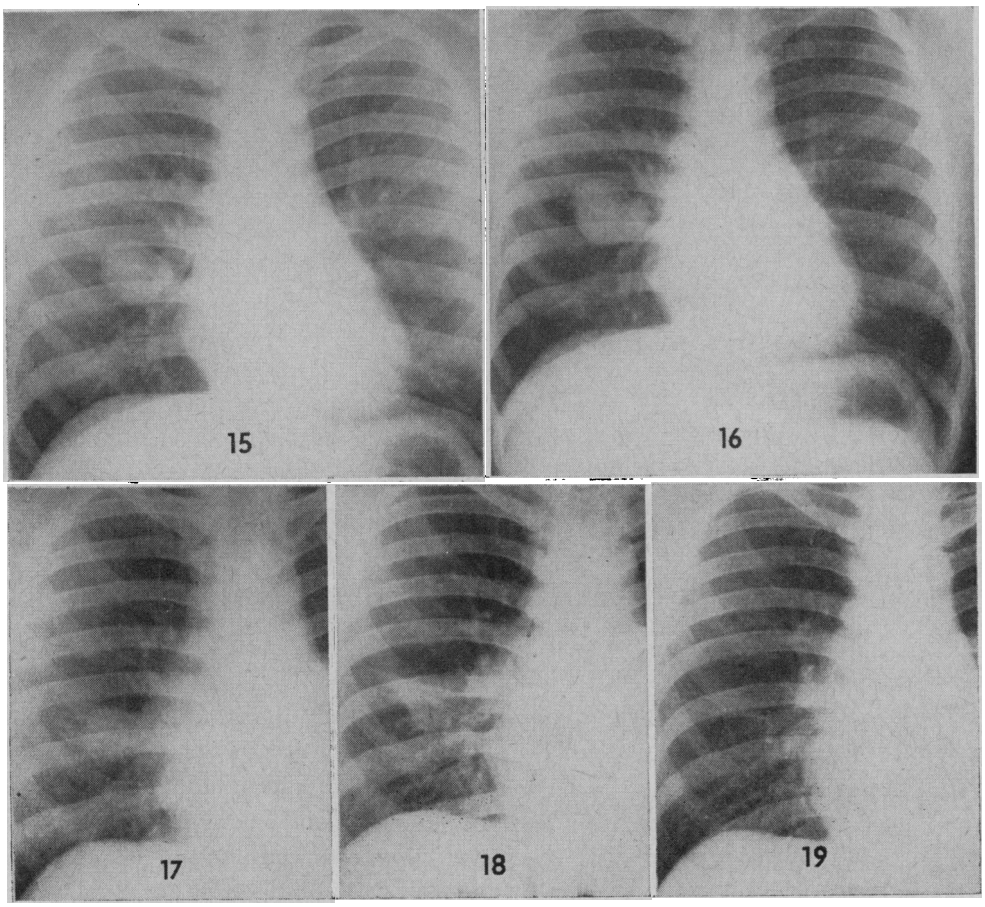
M.A., female, 27 years.—Films showing uncomplicated natural cure of pulmonary hydatid cyst. **Fig. 11.**—X-ray film 1949—cyst (4.5 x 4.0 cm.) left lung. **Fig. 12.**—X-ray film (March) 1950—cyst (5.0 x 4.5 cm.) has increased in size. **Fig. 13.**—X-ray film (December) 1950—cyst has disappeared, presumably coughed up. **Fig. 14.**—X-ray film 1952—no sign of cyst or residual lesion.

The annual x-ray surveys carried out by the Indian Health Service offer a unique and valuable opportunity to investigate prognosis in pulmonary hydatidosis. Some information has

already been provided and within the next few years much more will become available.

Hydatid cysts of the liver do not have a natural avenue of escape as in the case of pulmonary cysts. As a result they continue to grow, sometimes reaching large dimensions (Fig. 4). Large hepatic cysts may cause disease through pressure or they burst and give rise to anaphylaxis as well as scattering hundreds of potentially new cysts in the tissues. However, from the relatively large numbers of calcified cysts, most of them under 5 cm., seen in the liver in a review of x-ray films of Indians from endemic hydatid infection areas, I am led to the belief that a high percentage of all hydatid cysts of the liver in the human host are rendered non-viable naturally, and cease to grow. These dead cysts become calcified and are no longer a threat to their host. An example of a small non-viable calcified cyst of liver is seen in Fig. 4 in a position just below the large cyst pushing up the right diaphragm. Hydatid cysts in other parts of the body, as in the brain or in the bones are, of course, a serious threat to the health and indeed the life of their host.

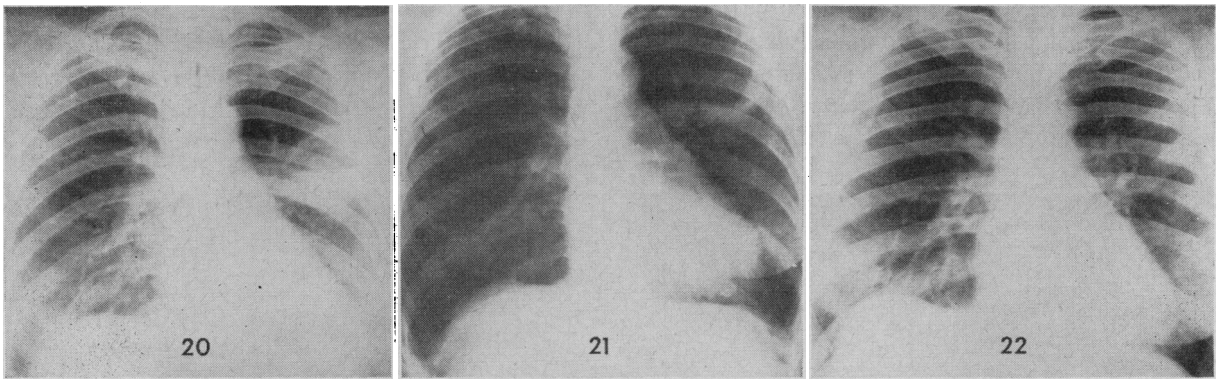
While the present survey collected certain data on the epidemiology of hydatid infections, a great many areas have not been surveyed; no studies have been made in the Yukon, in the Northwest Territories north of Great Slave Lake and in the Mackenzie River delta, in the eastern Arctic, or in Saskatchewan, Manitoba, Ontario, or Quebec; information from these areas would be most desirable. Further information on hydatid infection in wild herbivores and *E. granulosus* infections in wild carnivores is needed. The possibility that rodents may play a part in sylvatic echinococcosis should be considered and appropriate studies be made to investigate this matter.



S.F., female, 27 years.—Films showing natural cure of pulmonary hydatid cyst in spite of complications. **Fig. 15.**—X-ray film 1947—cyst (4.5 x 3.5 cm.) right lung. **Fig. 16.**—X-ray film 1949—cyst (5.3 x 4.1 cm.) shows slow rate of growth. **Fig. 17.**—X-ray film 1950—cyst shadow (3.5 x 3.0 cm.) shows reduction in size; the cyst has probably ruptured with incomplete evacuation. **Fig. 18.**—X-ray film 1951—cyst shadow is further reduced with some fibrous changes. **Fig. 19.**—X-ray film 1952—cyst has disappeared with no important residual lesion.

The willing co-operation and assistance of Federal and Provincial employees throughout the course of this investigation is gratefully acknowledged. The Indian

Agents and their assistants, the Federal and Provincial Game Wardens and Game Biologists, and the Royal Canadian Mounted Police were always helpful when called upon for transportation, information, and the many other services required while in the field. In particular, I would like to express my appreciation and thanks to Dr. P. S. Tennant, Regional Superintendent, Indian Health Service, British Columbia, retired, whose interest in this subject and knowledge gained by earlier investigations proved of great value; to the Superintendent, Miller Bay Hospital, Prince Rupert, for his generous co-operation; and to the Superintendent and staff of the Charles Camsell Indian Hospital, Edmonton, for their help and interest. Special thanks are due to Dr. Tom Orford, radiologist, Charles Camsell Hospital, for valuable assistance in reading and interpreting the x-ray films of suspected hydatid cases. The assistance rendered by Mr. E. Nahanee, secretary to the Native Brotherhood of British Columbia, in obtaining dogs for study and the technical assistance of Mr. Eric Smith, bacteriologist, Laboratory of Hygiene, Kamloops, is acknowledged with thanks. Space limitation precludes the naming of a number of others who were of assistance during the course of this study but nevertheless their assistance is greatly appreciated.



A.F., female, 38 years.—Films showing natural cure of pulmonary hydatid cyst in spite of complications. **Fig. 20.**—X-ray film 1949—cyst with fluid level (6.0 cm.) left lung, probably a partially evacuated cyst. **Fig. 21.**—X-ray film 1950—cyst with fluid level still present but reduced in size. **Fig. 22.**—X-ray film 1951—cyst cavity has disappeared with no residual lesion. The elevated right diaphragm suggests a hydatid cyst of the liver.

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EXPERIENCE WITH ANTICOAGULANT THERAPY IN THE TREATMENT OF CORONARY THROMBOSIS

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THIS REPORT deals with the experience of the Cardiac Service in Westminster Hospital, in the treatment of coronary thrombosis by anticoagulant therapy. This hospital has a closed staff, with a constant attending staff. The house staff is relatively senior, a junior intern having completed one year of a rotating internship; supervised by a man in the third year of his training. The supervisory nursing staff is also relatively permanent.

The drug used principally has been dicoumarol. The five cases in which Danilone was used showed in general similar behaviour, and are included in this series. Tromexan has not been used. Heparin has been used infrequently in the early phase of induction of anticoagulation.

Early in our experience, a consistent control prothrombin time was not achieved, and we observed two deaths from hæmorrhage in patients with congestive heart failure. Since this time, two technicians have been chosen to perform the tests, using a procedure giving controls varying from 12 to 16 seconds. Where a batch of thromboplastic substance has yielded results outside this range, it was discarded. It is a pleasure to acknowledge the enthusiastic co-operation of Professor J. C. Paterson and his staff in perfecting this technique.

The importance of a stable control of narrow range is now generally accepted.[1] It is known that the relationship between control and therapeutic level does not bear a linear relationship as the control increases. For example, a control

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