

# Management of *Echinococcus* *Multilocularis* Infections in Animals Guideline, 2019

Ministry of Health and Long-Term Care

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# 1 Preamble

The Ontario Public Health Standards: Requirements for Programs, Services, and Accountability (Standards) are published by the Minister of Health and Long-Term Care under the authority of section 7 of the *Health Protection and Promotion Act* (HPPA) to specify the mandatory health programs and services provided by boards of health.<sup>1,2</sup> The Standards identify the minimum expectations for public health programs and services. Boards of health are accountable for implementing the Standards including the protocols and guidelines that are referenced in the Standards. Guidelines are program and topic-specific documents which provide direction on how boards of health shall approach specific requirement(s) identified within the Standards.

# 2 Purpose

This guideline document was created to assist staff at boards of health with the management of suspected and confirmed cases of *Echinococcus multilocularis* (*E. multilocularis*) infections in animals, and human exposures to these cases.

# 3 Reference to the Standards

This section identifies the standard and requirements to which this guideline relates.

## Infectious and Communicable Disease Prevention and Control

**Requirement 15.** The board of health shall receive and respond to all reported animal cases of avian chlamydiosis (infection of birds with the causative agent of psittacosis in humans), avian influenza, novel influenza and *Echinococcus multilocularis* infection, in accordance with the *Health Protection and Promotion Act*, the *Management of Avian Chlamydiosis in Birds Guideline, 2018* (or as current), the *Management of Avian Influenza or Novel Influenza in Birds or Animals Guideline, 2018* (or as current); and the *Management of Echinococcus Multilocularis Infections in Animals Guideline, 2018* (or as current).

**Requirement 21.** The board of health shall ensure 24/7 availability to receive reports of and respond to:

- a) Infectious diseases of public health importance in accordance with the *Health Protection and Promotion Act*; the *Mandatory Blood Testing Act, 2006*; the *Infectious Diseases Protocol, 2018* (or as current); and the *Institutional/ Facility Outbreak Management Protocol, 2018* (or as current);
- b) Potential rabies exposures in accordance with the *Health Protection and Promotion Act*; the *Management of Potential Rabies Exposures Guideline, 2018* (or as current); and the *Rabies Prevention and Control Protocol, 2018* (or as current); and
- c) Animal cases of avian chlamydiosis, avian influenza, novel influenza, or *Echinococcus multilocularis* infection, in accordance with the *Health Protection and Promotion Act*, the *Management of Avian Chlamydiosis in Birds Guideline, 2018* (or

as current); the *Management of Avian Influenza or Novel Influenza in Birds or Animals Guideline, 2018* (or as current); and the *Management of Echinococcus Multilocularis Infections in Animals Guideline, 2018* (or as current).

## 4 Reporting of Animal Cases to Boards of Health

In accordance with the *Communicable Diseases – General, RRO 1990, Reg. 557*, a veterinarian or director of a laboratory who knows or suspects that one or more animals is infected with *E. multilocularis* shall notify the Medical Officer of Health within one business day.<sup>3</sup>

On an annual basis, the board of health shall provide veterinarians within its jurisdiction with information on how cases of *E. multilocularis* are to be reported to the board of health.

### 4.1 Reporting to the Ministry

The board of health shall:

- Report all cases of *E. multilocularis* in animals to the Ministry of Health and Long-Term Care (ministry) after receiving the report;
- Consult with the ministry with respect to managing all animal health aspects of the response; and
- Report to the ministry all actions taken in response to the animal case(s) of *E. multilocularis* infection.
- See Appendix A for background information on *E. multilocularis*, including information on the prevalence and distribution of the parasite in Ontario and Canada.

## 5 Response to Cases of *E. multilocularis* Infection in Animals

The identification of a confirmed or suspected case of *E. multilocularis* infection in an animal or animals shall trigger an investigation by the board of health in order to evaluate potential transmission to human contacts of the infected animal(s). The results of the investigation assist in determining actions to be taken to prevent or control the spread of *E. multilocularis* to humans.

See Appendix B for background information on *E. multilocularis* infections in animals, including transmission, incubation period, and clinical signs in both definitive and intermediate hosts.

See Appendix C for an overview of laboratory testing for *E. multilocularis* in animals.

## 5.1 Animal Case Follow-up

The board of health shall contact the owner and/or caretaker(s) of the infected animal(s) and/or the veterinarian reporting the case and collect the following information:

- Information sufficient to identify the infected animal (e.g. species, breed, colour, age, sex, as well as tattoos or microchip numbers where applicable, etc.);
- If symptomatic, date of onset and nature of clinical signs in all infected animals;
- If asymptomatic, date of diagnosis with either alveolar echinococcosis or intestinal infection with *E. multilocularis*;
- Current health status of infected animals;
- Length of time the owner has had the animal in their possession;
- The source the animal was obtained from;
- Animal's travel history, both within the province and outside the province;
- Details on how a diagnosis of *E. multilocularis* was made and any available test results for the animal;
- If the case is a dog with alveolar echinococcosis, whether a fecal sample was collected before or at the time of diagnosis;
- Whether or not the infected animal has been treated with an appropriate anthelmintic therapy (e.g. praziquantel, the only treatment currently approved in Canada) since the time of diagnosis with dates of all treatments administered;
- Whether or not canids or felids in the same household as the infected animal have been treated with appropriate anthelmintic therapy (praziquantel), with dates of all treatments administered;
- Location of all facilities where the animal(s) was/were housed for the six month period preceding the onset of clinical signs;
- Whether any new animals entered the household, facility or premises in the six month period prior to the onset of clinical signs or identification of an intestinal infection, which may have been a source of infection for the infected animal(s);
- Number, species, and individual descriptions of other animals housed with the infected animal(s);
- Contact information for all veterinarians or veterinary clinics that may have seen the animal in the preceding six month period;
- Names and contact information for any human exposures to the animal during the six month period prior to the diagnosis of infection or onset of clinical signs in the infected animal(s), including all caretakers, dog-walkers, and household contacts.;
- The amount of time the animal spends outside;
- Whether the animal is allowed to roam out of sight – if so, how often and where;
- Whether the animal visits any off-leash parks or play areas – if so, which ones;
- Whether the animal has consumed any wildlife carcasses;
- Whether the animal has been observed to hunt or consume rodents;
- Whether the animal has been observed to ingest canid feces; and
- Whether the animal has been observed to roll in feces or dead carcasses.

## 5.2 Management of Infected Animals

In accordance with the *Communicable Diseases – General, RRO 1990, Reg. 557*, a Medical Officer of Health who knows or suspects that an animal or animals are infected with *E. multilocularis*, shall act to prevent the spread of the infectious agent to humans.<sup>3</sup>

The board of health shall consult with the ministry to determine the appropriate management of the infected animal(s) which may be ordered by the Medical Officer of Health in order to reduce the risk of transmission of the infection to humans (e.g. an order requiring treatment of by a licensed veterinarian in order to reduce shedding of *E. multilocularis* eggs into the environment).

In cases where *E. multilocularis* infection occurs in animals forming part of an animal exhibit or at a facility where the general public comes into direct contact with the animals or their immediate environment, the Medical Officer of Health should consider ordering the closure of the exhibit or premises to the public until all potential risks of exposure have been assessed and adequately minimized.

Controlling *E. multilocularis* infections that occur in domesticated animals reduces human exposure. As a result, boards of health should consider advising pet owners in southern Ontario jurisdictions where the parasite is emerging not to allow dogs and cats to hunt wild animals, particularly rodents. Additionally, in endemic areas, regular anthelmintic treatment is advisable in animals allowed to roam outside, and fences should be placed around vegetable gardens to keep animals, especially dogs and other canids, away.

### 5.2.1 Treatment of Animals for *E. multilocularis*

Depending on the outcome of a risk assessment, the Medical Officer of Health may order that an animal with a suspect or confirmed intestinal *E. multilocularis* infection be treated in order to reduce the risk of human exposures to *E. multilocularis* eggs shed by the animal. If treatment is deemed appropriate, the Medical Officer of Health shall require that treatment to be supervised by a licensed veterinarian.

Note: In definitive hosts, *E. multilocularis* infection can be treated effectively with anthelmintic drugs. Praziquantel is effective against both juvenile and adult parasites, and is the only treatment currently approved in Canada.

Note: Dogs with alveolar echinococcosis alone do not present a risk to human health. However, some dogs with alveolar echinococcosis will also have a patent intestinal *E. multilocularis* infection either at the time of diagnosis or historically. As a result, all confirmed cases of alveolar echinococcosis are to be presumed to have intestinal *E. multilocularis* and therefore present a risk of transmission of the disease to both their current and past close human contacts.

## 6 Management of Human Exposures

The board of health should identify all human exposures to an infected animal for the six month period preceding the diagnosis of alveolar echinococcosis (only in dogs) or intestinal infection of *E. multilocularis*.

Note: Only dogs, wild canids, cats and wild felids can develop patent intestinal infections and shed the parasite's eggs in their feces. Other species (such as non-human primates or rodents) do not shed parasite eggs in their feces, and are only a concern with respect to human exposures if there is a risk that they may have (had) parasite eggs adhered to their fur as a result of exposure to those eggs in their environment.

Note: Investigation of human exposures to dogs, cats or other definitive host species such as wild canids is important to identify situations where prophylactic treatment of those contacts may be indicated. Concerns regarding human exposure apply to dogs with intestinal infections as well as dogs with alveolar echinococcosis, since the latter group may also have concurrent intestinal infections. Dogs are no longer considered infectious after 72 hours of appropriate anthelmintic treatment. However, determining the onset of infectivity in a given dog is difficult because of the potential for long-term intestinal infection or repeated infection as a result of multiple exposures.

Note: Depending on whether the infected animal(s) has/have been known to roll in feces or dead carcasses, handling of the animal's fur without consistent and routine hand hygiene immediately thereafter may also represent a risk of infection to humans. This is due to the fact that *Echinococcus* eggs have been shown to adhere to the coat of dogs, and particularly to the hairs around the anus, on the thighs, muzzles, and on paws.<sup>4</sup>

The board of health shall conduct a risk assessment for each identified human exposure to the infected animal, taking into consideration the following factors:

- Whether the individual ever handles the animal's feces, whether directly or indirectly (through a bag or a glove);
- Whether the individual always washes or sanitizes their hands after handling the feces;
- Whether the animal is allowed to lick the individual's face or mouth;
- Whether the animal has free run of the household, or is restricted to certain rooms or areas;
- Whether the animal uses a crate or carrier – if so, does the individual clean the crate or carrier;
- Whether the individual ever bathes the animal – if yes, how often;
- Whether the animal is ever dewormed – if yes, how often, with which product, and what was the date of the last deworming treatment; and
- How regularly does the individual wash or sanitize their hands after petting or handling the animal.

The board of health shall inform all persons that may have handled an infected animal or its feces of the potential health risks associated with this exposure.

See Appendix D for information on *E. multilocularis* infections in humans, including transmission, incubation period and clinical signs.

## 6.1 Infection prevention and control for Caretakers of Animals

The board of health shall provide all identified human contacts of an infected animal with information on how the risk of exposure to *E. multilocularis* eggs in the environment can be mitigated, including:

- hands should always be thoroughly washed after handling pets, farming, gardening or preparing food, and before eating;
- wild carnivores, especially canids and felids, should be discouraged from coming close to homes. If these animals or their carcasses must be handled, gloves should be used; and
- Anyone who handles an infected animal or material that may be contaminated with *E. multilocularis* eggs (e.g. animal feces) should use appropriate personal protective equipment (i.e. disposable gloves).

## 6.2 Serological Testing of Human Exposures to an Infected Animal

Currently, serologic testing for *E. multilocularis* is not performed in Canada. Serum specimens submitted to the Public Health Ontario Laboratories with a requisition for “alveolar hydatid” or “*E. multilocularis*” are sent for reference testing in Switzerland.

The board of health, in consultation with the parasitologist at Public Health Ontario, shall recommend serological testing of all human contacts identified to be at high risk of exposure due to close contact with a dog with confirmed alveolar echinococcosis, or any animal with a confirmed intestinal *E. multilocularis* infection, on the basis of the outcome of a risk assessment. The purpose of serological testing is to detect *E. multilocularis* cysts in the early stages of infection, when they are most treatable.

Human exposures should be managed by undergoing repeated serological testing after the most recent potential exposure to eggs of the parasite, with no further follow-up indicated if all specimens are negative for any serological evidence of exposure.

## 6.3 Reporting of Human Cases

*E. multilocularis* infection in humans is designated as both a disease of public health significance and a communicable disease under *Designation of Diseases*, O. Reg. 135/18.<sup>4</sup> Any identified human cases meeting the provincial case definition provided in the Appendices to the *Infectious Diseases Protocol, 2018* (or as current) shall be reported to the ministry by the board of health.

## 7 Management of Animal Contacts

The investigation of the case(s) of *E. multilocularis* infection in a companion animal should attempt to identify all other animals in the household that have likely been exposed to the same potential sources of *E. multilocularis*.

Close and/or household canine and feline contacts of the infected animal should be considered as suspected cases of *E. multilocularis* for the purposes of management (see section 3.2).

## 8. Cleaning and Disinfection

In the course of investigating human exposures to animals with *E. multilocularis* infections, boards of health may need to provide recommendations for the cleaning and disinfection of premises where the animal(s) have been housed, in order to reduce risk of human infections due to the presence of viable *E. multilocularis* eggs in homes, kennels, etc.

*E. multilocularis* eggs can remain viable for up to a year in a moist environment at low temperatures. The eggs are cold resistant to  $-50^{\circ}\text{C}$ . *E. multilocularis* eggs are inactivated by high temperatures (hot water of  $85^{\circ}\text{C}$  or above is effective) and dessication. They can also be killed by freezing at  $-80^{\circ}\text{C}$  for 48 hours or  $-70^{\circ}\text{C}$  for 4 days.

The two most important factors in reducing the longevity of the eggs are dessication and high temperatures. *E. multilocularis* eggs are killed by boiling water or dry heat, which remains the most reliable and effective method for disinfection. Heat can be applied in various forms for disinfection. Concrete floors may be disinfected using boiling water or hot water/steam mixtures. Washing clothing and other laundry in a washing machine at  $+60^{\circ}\text{C}$  for one hour will disinfect items contaminated with *E. multilocularis* eggs.<sup>5</sup>

If dogs or cats with intestinal *E. multilocularis* infection have had access to living rooms or cars, the question for an adequate method of disinfection may arise. There is no satisfactory solution, but thorough cleaning using a vacuum cleaner, the focal application of dry heat (using a hair dryer or electric heater, etc.) at sites preferably used by the animals, and heat treatment of any items such as blankets or pet beds which can be laundered may help to reduce the infection risk. During the summer, cars can warm up to temperatures detrimental to *E. multilocularis* eggs when exposed for several hours to direct sunshine.<sup>5</sup>

If soil in yards or gardens has been contaminated with *E. multilocularis* eggs, the surface layer (approximately 1-2 cm) should be removed, and the ground thoroughly burned with a source of high heat such as a blow torch. It should be considered that, although blow torches generate high heat, decontamination may not be complete because of the rapid decrease of temperature after contact of the flame with soil, especially moist soil.<sup>5</sup>

Chemical disinfection is unreliable for clinical samples, and most of the commercial disinfectants with activity against viruses and bacteria are ineffective against

*E. multilocularis* eggs. Sodium hypochlorite at a minimum concentration of 3.75% in water will destroy a majority of eggs present, but the effect of this disinfectant is variable and depends on the actual chlorine concentration, on temperature, and the depth of penetration. It does not penetrate easily into organic materials. The concentration of active chlorine may decrease rapidly in a solution by evaporation. Therefore, high quality and fresh sodium hypochlorite solutions should be used. Sodium hypochlorite solutions of at least 3.75% concentration may be used to wipe down work surfaces (1 hour contact time), soak instruments (3-5 min contact time) plastic trays and materials, glassware, etc.<sup>5</sup> Appropriate personal protective equipment (e.g. eye protection, gloves, etc.) should be worn when handling sodium hypochlorite solutions.

## References

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# Appendix A: Background Information on *Echinococcus Multilocularis*

## 1. Background Information on *E. multilocularis* Infections

*E. multilocularis* is a small zoonotic tapeworm found extensively throughout the northern hemisphere. This tapeworm has an indirect life cycle, which means it needs to develop in both an intermediate and a definitive host in order to complete its life cycle and reproduce.

Intermediate hosts are animals in which *E. multilocularis* eggs develop into the larval (immature) life stage of the tapeworm. Definitive hosts are animals in which the larval stage of *E. multilocularis* develops into adult tapeworms in the intestine. Definitive hosts then shed *E. multilocularis* eggs into the environment in their feces.

In many cases, the parasite cycles through specific predators or scavengers and their prey, in a naturally occurring wildlife cycle. When an intermediate host ingests the eggs of the tapeworm, the larvae are released from the eggs and travel through the blood or lymphatic system to the target organs where they form multiple small cysts in the tissues of the intermediate host. The disease caused by the resulting lesions in the organs of the intermediate host is called alveolar echinococcosis. When a definitive host ingests the cysts (usually by consuming the intermediate host itself, or its infected tissues) the larvae in the cysts can then develop into mature tapeworms in the small intestine of the definitive host to complete the life cycle of the parasite.

The definitive hosts of *E. multilocularis*, which are primarily wild canids, such as foxes and coyotes, carry the adult tapeworms asymptotically. Intermediate hosts are initially asymptomatic; however, the growth of the larvae, which typically form multiple small cysts in the liver, can lead to illness and death.

While *E. multilocularis* usually cycles in wildlife, with a variety of carnivores serving as definitive hosts, the adult tapeworms can also mature in domestic dogs and cats. Intermediate hosts in the wildlife cycle are usually small mammals, but domesticated animals and humans can also be infected by ingesting *E. multilocularis* eggs, thus becoming accidental intermediate hosts for the parasite.

*E. multilocularis* cysts typically resemble tumors and are very invasive. Eventually, they can completely infiltrate an organ, and spread to other organs and tissues nearby. The cysts can also metastasize to distant sites such as the central nervous system, the lungs or bones.

*E. multilocularis* is a major public health concern in countries where the tapeworm has become established in densely populated areas (e.g. Switzerland), and is an emerging concern in Ontario.

## 2. *E. multilocularis* in Canada and Ontario

Prior to 2009, *E. multilocularis* had never been diagnosed in a dog in Canada. However, in 2009, hepatic alveolar echinococcosis was diagnosed in a 3 year old dog that had never been outside British Columbia. In 2012, a second case was diagnosed in a 2 year old dog that resided in southern Ontario and a third case was diagnosed in a 4 year old dog that lived in Alberta and Manitoba. Between 2013 and 2016, four additional cases were diagnosed in southern Ontario. None of the 7 dogs were related, all 7 had no travel history outside of Canada, and 5 of the dogs had lived their entire lives in provinces where *E. multilocularis* had never been diagnosed prior to the occurrence of these cases. Since then, alveolar echinococcosis has also been identified in two lemurs who were allowed to roam outdoors in southern Ontario and were coming into contact with wildlife.

A research study conducted by the University of Guelph in 2015-2017 confirmed that *E. multilocularis* has become established in coyote and fox populations across southern Ontario, with potential hotspots of higher rates of infection in some health units.

Passive wildlife surveillance also identified *E. multilocularis* infection in a chipmunk from southern Ontario in 2016, further confirming that all stages of the tapeworm's lifecycle are now present in the Ontario environment.

## Appendix B: *Echinococcus Multilocularis* Infections in Animals

### 1. Transmission to Animals

*E. multilocularis* infection of animals occurs when an animal either ingests infective *E. multilocularis* eggs found in the environment, or consumes tissues from an intermediate host which contain mature *E. multilocularis* cysts. Intermediate hosts cannot transmit *E. multilocularis* infection by casual contact.

### 2. Incubation Period in Animals

In definitive hosts, the period between the ingestion of mature *E. multilocularis* cysts and the appearance of adult tapeworms shedding eggs in the intestine is between 28 and 35 days. Experimentally infected dogs and foxes have shed eggs for 1 day to 4 months, with shedding becoming more irregular during the later stages. Adult tapeworms are estimated to survive in the definitive host for a maximum of approximately 5 months. Definitive hosts often become reinfected if they are re-exposed.

In larger intermediate hosts, *E. multilocularis* cysts grow slowly and do not usually become symptomatic until they damage adjacent tissues and organs. However, in small mammals, such as rodents, the infection can kill the intermediate host within weeks.

### 3. Clinical Signs of *E. multilocularis* in Animals

Clinical signs of *E. multilocularis* infections in animals depend on the animal species, and whether it is serving as a definitive host or an intermediate host for the tapeworm. Dogs can be either definitive hosts, or intermediate hosts, or in some cases both at the same time.

Since the late 1980s, cases of alveolar echinococcosis, primarily involving the liver, have been described in dogs in Switzerland, Germany, France, and Belgium. These cases are thought to occur as a result of either the ingestion of large numbers of eggs from the environment, or as a result of autoinfection associated with the presence of adult tapeworms in the small intestine.

Approximately 30% of dogs presenting with alveolar echinococcosis are also found to have adult tapeworms in their intestine and be shedding eggs into the environment.

#### 3.1 Definitive Hosts

*E. multilocularis* worms are usually carried asymptotically in their definitive hosts. Large numbers of parasites may be able to cause enteritis and diarrhea, but this seems to be rare. Thousands of adult worms have been found in asymptomatic dogs and foxes.

Adult *E. multilocularis* tapeworms are tiny, usually from 1-5 mm in length, and are attached to the small intestine.

### 3.2 Intermediate Hosts

*E. multilocularis* usually affects the liver, but in more advanced cases, metastatic lesions may be found in other organs, including the lungs and brain. The tumour-like cysts can kill rodents within a few weeks of infection.

Symptomatic infections, associated primarily with lesions in the liver and abdominal cavity, have been reported in dogs. The most consistent presentation of symptomatic infection has been progressive abdominal enlargement without severe clinical signs. Ascites, abdominal masses, hepatomegaly, dyspnea, intermittent diarrhea, nausea, vomiting, and weight loss have also been reported. In advanced disease, cysts may seed multiple organs, causing severe illness and death within weeks. In one dog, a single cystic lesion was reported in the subcutaneous tissues.

## Appendix C: Overview of *Echinococcus Multilocularis* Testing in Animals

*E. multilocularis* infections in dogs and cats cannot be identified definitively through routine fecal testing; *E. multilocularis* eggs in feces are morphologically indistinguishable from other tapeworm species.

Enzyme-linked immunosorbent assays (ELISAs) that detect *E. multilocularis* antigens in fecal samples can be used to screen definitive hosts but are not species specific. Polymerase chain reaction (PCR) assays designed for fecal samples are mainly used to confirm the infection or to identify eggs in the feces.

In animal intermediate hosts, alveolar echinococcosis is mainly diagnosed at necropsy, or occasionally at surgery. Specifically, histological examination of tissue, combined with periodic-Schiff positive staining, provides a tentative diagnosis; species-specific PCR testing of tissue provides a confirmatory diagnosis.

In Ontario, diagnostic testing capacity for *E. multilocularis* infections in animals is under development. Currently, the Animal Health Laboratory at the University of Guelph offers a PCR assay and sequence analysis that has been validated for use on liver tissue and abdominal fluid from dogs with alveolar echinococcosis.

Serological tests are not generally used for diagnosis in domesticated animals. However, seropositivity can provide evidence of exposure prior to development of the larval (intermediate) stage. Thus, serology is a useful screening test in dogs that regularly consume wild/domestic canid feces. At present, canine serology testing for *E. multilocularis* is only available in Switzerland. However, in the near future, it is anticipated it will be available through Western College of Veterinary Medicine, University of Saskatchewan, Saskatoon.

## Appendix D: *Echinococcus Multilocularis* Infections in Humans

### 1. *E. multilocularis* in Humans

Human infection with *E. multilocularis* causes a disease known as alveolar echinococcosis, which is uncommon, but very serious and difficult to treat. The larvae of the tapeworm grow as multiple, small, budding cysts, which can infiltrate entire organs (typically the liver) and disseminate to distant sites including the brain, lungs, mediastinum and other organs or tissues. Many infections are diagnosed late, when the risk of a serious or fatal outcome is increased. Depending on the stage of the disease, treatment may be curative, or may only prolong survival and ameliorate the symptoms. The 10-year survival rate of patients on long-term anti-parasitic drug treatment is reported to be 80%. Because the multilocular cyst is very invasive and also metastasizes, a complete surgical cure is rare except in the early stages of infection. Without treatment, 70-100% of all cases are fatal.

### 2. Transmission to Humans

Humans act as accidental intermediate hosts for *E. multilocularis*, and are infected when they ingest tapeworm eggs shed by a definitive host. The eggs may be eaten in foods such as vegetables, fruits or herbs, or ingested with contaminated water. They can also stick to the hands when a person pets an infected dog or cat, handles a wild animal or its carcass, or touches contaminated soil and vegetation.

Dogs are particularly important in zoonotic disease transmission due to their ability to act as a definitive host for the parasite, and their close relationships with humans. It should also be recognised that parasite eggs are immediately infective for people in fresh feces.

Uninfected pets may carry the eggs on their fur if they contact the feces of infected wild hosts. This is probably more common in dogs, which may roll in feces.

Human-to-human transmission does not occur.

### 3. Incubation Period in Humans

The incubation period for development of disease due to *E. multilocularis* infection varies, but can be as long as 5-15 years, if the cysts grow slowly and are not in a critical location.

### 4. Clinical Signs of Alveolar Echinococcosis in Humans

The primary lesion of alveolar echinococcosis is almost always in the liver, and the course of disease is slow. During the early stages, the infection is usually asymptomatic.

Larger lesions cause hepatomegaly and epigastric pain. Ascites, malnutrition, jaundice and signs of hepatic failure may occur in later stages of the disease.

Symptoms of alveolar echinococcosis are primarily cholestatic jaundice (in about a third of cases) and/or epigastric pain (about a third of cases). In the remaining third of cases, alveolar echinococcosis is detected incidentally during medical examination for symptoms such as fatigue, weight loss, hepatomegaly, or abnormal routine findings.

Sometimes, the primary lesion dies early in its development (i.e. an aborted infection), and the person remains asymptomatic.

