

Echinococcosis

Echinococcosis,
Hydatidosis,
Hydatid disease

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Etiology

Echinococcosis is caused by several species of *Echinococcus*, tiny cestode parasites in the family Taeniidae. The two most important species are *Echinococcus granulosus* and *Echinococcus multilocularis*. *E. granulosus* causes a type of echinococcosis known as cystic echinococcosis, unilocular echinococcosis or cystic hydatid disease. Different strains of *E. granulosus* can be found in sheep, cattle, pigs, horses and reindeer. All of the strains, except possibly the horse strain, infect humans. *E. multilocularis* causes a type of echinococcosis known as alveolar echinococcosis, alveolar hydatid disease, multilocular echinococcosis or multivesicular hydatidosis.

Echinococcus vogeli and *Echinococcus oligarthrus* are species of minor importance. These organisms are found mainly in wildlife and rarely affect humans. Human infection with these parasites is known as polycystic echinococcosis.

All *Echinococcus* spp. have an indirect life cycle, cycling between a definitive and an intermediate host. Intestinal infections occur in the definitive host, and tissue invasion is seen in the intermediate host. Carnivores are definitive hosts for *Echinococcus*, and usually have no symptoms of infection. Disease may be seen in the intermediate hosts, including humans.

Geographic Distribution

E. granulosus occurs worldwide but is most common in temperate, rural sheep-raising areas. In the U.S., this parasite is mainly reported from the western states. *E. multilocularis* is found primarily in the northern hemisphere. This parasite is either expanding its geographic range or is being identified in new areas due to increased surveillance. It has been found in Canada, the United States, Europe, Japan, Russia, India, Turkey, Iraq, China and in a tiny pocket in northern Africa. In Europe, this parasite was known to exist in France, Germany, Austria and Switzerland in the 1980s, but has recently been identified in the Netherlands, Belgium, Luxembourg, Poland, the Czech Republic, the Slovak Republic, Italy and Hungary. In the U.S., *E. multilocularis* mainly occurs in Alaska and the northcentral states from eastern Montana to central Ohio. *E. vogeli* and *E. oligarthrus* are found only in Central and South America.

Transmission and life cycle

Echinococcus species have an indirect life cycle, and must develop in both an intermediate and a definitive host. In many cases, the parasite cycles through specific predators or scavengers, and their prey.

Echinococcus granulosus

The definitive hosts for *E. granulosus*, mainly canids, become infected when they ingest cysts (metacestodes) in the tissues of the intermediate hosts. The cysts develop into tapeworms, which mature in the host's small intestine. Gravid proglottids or eggs are shed in the feces, and are immediately infective. *Echinococcus* eggs have a sticky coat that will adhere to an animal's fur and other objects. Flies can also act as mechanical vectors. In addition, the shed proglottids may perform rhythmic contractions that help to disperse the eggs widely on pastures.

Under ideal conditions, *E. granulosus* eggs remain viable for several months in pastures or gardens and on household fomites. They survive best under moist conditions and in moderate temperatures. Viable eggs have been found in water and damp sand for 3 weeks at 30°C, 225 days at 6°C and 32 days at 10-21°C. The eggs survive for only short periods of time if they are exposed to direct sunlight and dry conditions.

The intermediate hosts include a large number of domestic and wild animals, particularly herbivores. Humans can also be infected. If an intermediate host ingests the eggs, the larvae are released, penetrate the intestinal wall, and are carried in blood or lymph to the target organs. Parasites can develop into cysts in many different organs, but are found most often in the liver and, less frequently, the lungs. The cysts grow slowly. Most *E. granulosus* cysts are 1-7 cm in diameter when they are discovered, but some may eventually reach 20 cm. Each fluid-filled cyst is surrounded by a fibrous wall from the host and contains two walls derived from the parasite: an outer laminated membrane and an



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inner membrane called the germinal layer. Brood capsules develop from the germinal membrane. Each brood capsule contains one to several invaginated heads (protoscolices) that can develop into adult tapeworms if they are ingested by the definitive host. Capsules and protoscolices either float freely in the hydatid fluid or adhere to the wall with a peduncle; the capsules and protoscolices that float freely are known as “hydatid sand.” If a cyst ruptures, the hydatid sand can develop into new cysts. Some cysts are sterile; they either never produce brood capsules, or they become sterile after bacterial infection or calcification. The percentage of sterile cysts varies with the intermediate host.

Strains of *E. granulosus* may be found in specific host-prey cycles. These strains have a degree of host adaptation and a distinct geographic range; a strain that infects one intermediate host may be less able, or unable, to infect other intermediate hosts. The dog-sheep cycle is most likely to result in human infections. Other cycles include dog-camel, dog-horse, wolf-moose, wolf-deer and coyote-deer.

Echinococcus multilocularis

The life cycle and transmission of *E. multilocularis* is very similar to that of *E. granulosus*. A variety of carnivores serve as the definitive hosts. *E. multilocularis* eggs are cold-resistant to -50°C . The intermediate hosts are usually small mammals, particularly rodents, but domestic animals and humans can also be infected.

In both animal and human intermediate hosts, the primary metacestodes are found almost exclusively in the liver. The germinal membrane of *E. multilocularis* proliferates externally, rather than internally, to form a multilocular structure with many small cysts. These vesicles are usually 1-10 mm in diameter, but occasionally grow as large as 20-30 mm, and are embedded in fibrous connective tissue or a semisolid matrix. Hundreds to thousands of protoscolices develop from the germinal membrane in some intermediate hosts.

E. multilocularis cysts resemble tumors: they are not contained within a capsule and are very invasive. The cysts can also metastasize to other sites such as the central nervous system (CNS) or lungs.

Echinococcus vogeli

The definitive hosts for *E. vogeli* are bush dogs and dogs, and the intermediate hosts are rodents. The metacestode is found primarily in the liver, but can also be seen in the lungs and other organs. *E. vogeli* cysts develop both externally and internally, resulting in multiple vesicles. In humans, *E. vogeli* is invasive.

Echinococcus oligarthrus

The definitive hosts for *E. oligarthrus* are wild felids, and the intermediate hosts are rodents. Cysts develop in a variety of internal organs and the muscles. The cysts resemble those of *E. vogeli* and can reach up to 5 cm in diameter.

Transmission to humans

Humans act as intermediate hosts for all four *Echinococcus* spp., and are infected when they ingest tapeworm eggs from the definitive host. The eggs may be found on foods such as vegetables, fruits or herbs, or in contaminated water. They can also stick to the hands when a person handles or pets an infected dog, cat, wild animal or its carcass. The eggs are then transferred to the mouth on the hands. Uninfected pets, particularly dogs, may also carry the eggs on their fur if they come in contact with the feces of infected wild hosts.

Disinfection

Some sources state that *Echinococcus* spp. are susceptible to 1% sodium hypochlorite or 2% glutaraldehyde. Others suggest that chemical disinfection is unreliable, but a percentage of the eggs may be destroyed by sodium hypochlorite. *Echinococcus* eggs are also destroyed by heat (hot water of 85°C or above is very effective) and desiccation. They can also be killed by freezing at -80°C for 48 hours or -70°C for 4 days.

Laboratories can be decontaminated by setting the environmental conditions to 40% humidity combined with 30°C room temperature for at least 48 hours.

Infections in Humans

Incubation Period

The incubation period for echinococcosis varies from months to years. It can be as long as 20-30 years, if the cyst grows slowly and is not in a critical location.

Clinical Signs

The symptoms of echinococcosis vary with the size and the location of the metacestodes. Until the cysts become large enough to damage adjacent tissues and organs, they are usually asymptomatic. The clinical signs are those of a mass lesion.

Cystic echinococcosis (Echinococcus granulosus)

E. granulosus cysts grow very slowly and can remain asymptomatic for many years. They are usually well tolerated until they cause pressure on surrounding tissues. The symptoms resemble those of a slowly growing tumor. Approximately 60-70% of *E. granulosus* cysts are found in the liver and 20-25% in the lungs. The remaining 10% can be found almost anywhere in the body including the bones, kidneys, spleen, muscles, CNS and behind the eye. Depending on the location, some cysts can become very large and may contain up to several liters of fluid. Others in critical locations such as the brain become symptomatic when they are still small. Nonspecific signs may include anorexia, weight loss and weakness. If a cyst leaks or ruptures, it can cause allergic reactions including fever, asthma, pruritus, urticaria or

life-threatening anaphylaxis. Ruptured cysts can disseminate. Other symptoms vary with the location(s) of the cysts:

In the liver, common symptoms include abdominal pain, nausea, vomiting or indigestion. If the cyst obstructs the biliary system, it can mimic gallstones and cause pain or cholestatic jaundice.

Cysts in the lungs can cause respiratory signs including cough, chest pain and hemoptysis, particularly if they rupture. Abscess formation and pneumothorax can also be seen, and fragments of the capsule may cause arterial embolism. Neurologic signs, including blindness and seizures, may be seen if the brain or spinal cord is affected. Cysts in the bones can destroy the structure of the bone and result in spontaneous fractures. In the heart, a cyst can result in pericardial effusion, heart block or other arrhythmias, and sudden death. Cysts in any location may become secondarily infected by bacteria.

E. granulosus cysts can also be asymptomatic throughout the individual's life, and may be incidental findings at surgery or autopsy.

Alveolar echinococcosis - *Echinococcus multilocularis*

The primary lesion of *E. multilocularis* is always in the liver, and the course of the disease is slow. During the early stages, the infection is usually asymptomatic. Larger tumors cause hepatomegaly, epigastric pain, and often splenomegaly. Ascites, malnutrition, jaundice and signs of hepatic failure may occur in the late stages of disease. *E. multilocularis* cysts are very dangerous as they are not enclosed within a membrane and invade tissues by budding outward; alveolar hydatidosis is progressive and malignant. The cysts can spread to nearby organs and metastasize to the brain, lungs, mediastinum and other organs or tissues.

Polycystic hydatidosis - *E. vogeli* and *E. oligarthrus*

E. vogeli most often affects the liver. In humans, this metacestode is slow growing but invasive. Common symptoms include hepatomegaly, abdominal distension, weight loss, fever, abdominal pain, jaundice, anemia and hemoptysis. Palpable masses may be present in the liver or abdomen, and there may be signs of portal hypertension.

E. oligarthrus localizes in the internal organs and muscles. Little is known about this organism and human infections are extremely rare.

Communicability

Echinococcosis is not transmitted from person to person. Humans can transmit the infection to the definitive hosts, but this does not occur in most societies due to cultural practices.

Diagnostic Tests

In humans, echinococcosis is diagnosed mainly with imaging techniques such as ultrasonography, radiology, magnetic resonance imaging (MRI) or CT scanning, and is supported by positive serologic tests. Serologic assays include enzyme-linked immunosorbent assays (ELISAs), indirect immunofluorescence, immunoelectrophoresis and immunoblotting. Indirect hemagglutination, complement fixation and latex agglutination tests are now rarely used. Some serologic tests can distinguish between antibodies to *E. multilocularis* and *E. granulosus*. Some people with cysts do not develop detectable antibodies.

Biopsies are occasionally used in diagnosis, but there is risk of cyst leakage or rupture. Tests to detect antigens in serum are available in some countries, but are not as sensitive as serology. PCR techniques and immunofluorescence/immunohistochemical staining can identify *E. multilocularis* in the tissues.

Treatment

Most cysts are removed surgically. In some situations, particularly with alveolar echinococcosis, it may not be possible to remove the entire cyst. Long-term post-surgical treatment with anthelmintic drugs such as albendazole or mebendazole may be necessary to prevent the organism(s) from regrowing. In some cases, a long course of drug treatment may be an alternative to surgery. Another treatment option is the introduction of an anthelmintic drug into the cyst under ultrasonographic guidance. In severe cases of alveolar echinococcosis, a liver transplant may be an option.

Prevention

General measures to decrease the risk of infection include: All fruits and vegetables, particularly those picked in the wild, should be thoroughly washed. Fences should be placed around vegetable gardens to keep animals away. Wild canids should be discouraged from coming close to homes. Infections in dogs and cats should be prevented. If the pet becomes infected, it should be treated to prevent it from infecting humans. The hands should always be washed after handling pets. Wild foxes, coyotes or other wild canids, and their carcasses, should be handled with gloves. Meat, particularly canine intestines, should be thoroughly cooked before eating.

No human vaccines are available. Mebendazole and albendazole have been used prophylactically to prevent *E. granulosus* infections.

Morbidity and Mortality

Most cases of echinococcosis are of the cystic form. Cystic echinococcosis is particularly common in rural areas and areas with poor sanitation, particularly sheep-raising areas where dogs are given the entrails of livestock to eat. It is also prevalent when canine intestines are part of the human

diet (e.g. in parts of Kenya). Alveolar echinococcosis is relatively rare in humans, with an annual incidence of 0.02 to 1.4 cases per 100,000 persons. Higher infection rates can be seen in some populations: up to 98 cases per 100,000 persons occur in some population groups in Alaska, and 4% of the population is infected in one part of China. Hunters, fur trappers, fur traders, wildlife veterinarians and wildlife biologists have an increased risk of contracting alveolar echinococcosis.

Overall, the incidence of echinococcosis is thought to be less than 1 case per 100,000 persons in many parts of the world. Higher rates are seen in some regions: 13 cases per 100,000 persons in Greece, 143 cases per 100,000 persons in Argentina, 197 cases per 100,000 persons in the Xinjiang province of China, and 220 cases per 100,000 persons in Kenya's Turkana district. Echinococcosis is rare in the U.S., but cases of alveolar echinococcosis have been documented in Minnesota and Alaska and pockets of cystic echinococcosis occur among Basque sheep farmers in northern California and Native Americans in Arizona and New Mexico.

Although cystic echinococcosis is a serious and potentially fatal disease, the cysts are usually well tolerated unless they damage adjacent tissues or rupture. Many cysts are asymptomatic throughout the individual's life, and may be incidental findings at surgery or autopsy. Surgery can usually cure cystic echinococcosis; however, some infections are fatal, usually as a result of cyst rupture/anaphylactic shock or damage to vital organs. The prognosis for symptomatic cysts located in the brain, kidney, heart or other vital organs is grave.

Alveolar echinococcosis is rare but very serious; without treatment, 70-100% of all cases are fatal. Because the multilocular cyst is very invasive and also metastasizes, a complete surgical cure is rare except in the early stages of infection. Many infections are diagnosed late, when the risk of a serious or fatal outcome is high. Post-surgical treatment with anthelmintic drugs, either long-term or for life, can suppress the growth of the cysts. The 10-year survival rate of patients on long-term drugs is 80%.

Cysts due to *E. vogeli* and *E. oligarthrus* are very rarely seen in humans. Many of these infections have been fatal; in one study, all 72 patients died.

Infections in Animals

Species Affected

Echinococcus granulosus

The definitive hosts for *E. granulosus* are primarily members of the Canidae, including dogs, wolves, coyotes, foxes, jackals, hyenas and dingoes.

E. granulosus infects a wide variety of intermediate hosts, mainly herbivores such as sheep, goats, cattle, pigs, horses, buffalo, camels, giraffes, deer, antelope, gazelles, zebras, moose, reindeer, caribou, elk, vicuña, elephants, hip-

popotamuses, rabbits, kangaroos, wallabies and wombats. Infections have also been seen in mongooses, non-human primates and humans.

Wildlife reservoirs are important as maintenance hosts. Livestock can become infected from the eggs of wild canids, and dogs may become infected if they eat the internal organs of wildlife.

Echinococcus multilocularis

The definitive hosts for *E. multilocularis* are primarily foxes, particularly red and arctic foxes. Other definitive hosts are wolves, coyotes, raccoon dogs, dogs and cats. Cats appear to be somewhat less susceptible to infection than dogs.

The intermediate hosts for *E. multilocularis* are usually small mammals including voles, lemmings, shrews and mice. Humans and, rarely, domestic mammals can also act as intermediate hosts: cysts have been reported in dogs, domestic and wild pigs, horses, nutria and non-human primates. In two infected dogs, there were concurrent infections with adult *E. multilocularis* in the intestines and multilocular cysts in the liver.

Echinococcus vogeli

The definitive hosts for *E. vogeli* are the bush dog (*Speothos venaticus*), a canid found in South America, and dogs. The intermediate hosts for *E. vogeli* are the paca (*Cuniculus paca*) and nutria, both rodents. Humans can act as intermediate hosts but this is very rare.

Echinococcus oligarthrus

The definitive hosts for *E. oligarthrus* are wild felids including pumas, jaguars, ocelots, Geoffroy's cats, lynxes, pampas cats and jaguarundis. Domestic cats may also be able to serve as definitive hosts. The intermediate hosts for *E. oligarthrus* are wild rodents including agouti, paca and the spiny rat. Humans can act as intermediate hosts but this is very rare.

Incubation Period

Clinical signs are not usually seen in the definitive host. The prepatent period varies with the species, with a range of 32 to 80 days for *E. granulosus* and 28 to 35 days for *E. multilocularis*.

Echinococcus cysts grow slowly and do not usually become symptomatic until they damage adjacent tissues and organs. *E. multilocularis* can kill rodent intermediate hosts within weeks. In larger mammals, the incubation period is unknown. The incubation period for *E. granulosus* is also unknown; however, many asymptomatic cysts are found in livestock at slaughter, suggesting a long incubation period.

Clinical Signs

Definitive hosts

Echinococcus spp. are usually carried asymptotically in their definitive hosts. Large numbers of parasites may be able to cause enteritis; however, thousands of adult parasites have been found in asymptomatic dogs and foxes.

Intermediate hosts – *Echinococcus granulosus*

There is little information on natural infections with *E. granulosus* in domestic animals. The cysts grow slowly and are usually asymptomatic until they are large enough to put pressure on adjacent tissues and organs. Livestock are often slaughtered before this occurs. If clinical signs are seen, they are those of a mass lesion and vary with the organ affected. Most cysts are found in the liver and lungs, but they may also be found in many other organs. Symptoms that have been reported occasionally in sheep include hepatic disorders, ascites and jaundice, as well as bronchopneumonia, heart failure, decreased growth, weakness and lameness.

Intermediate hosts – *Echinococcus multilocularis*

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 tumor-like cysts can kill rodents within a few weeks of infection. Symptomatic infections, associated with lesions in the liver and abdominal cavity, have also been reported in dogs. The symptoms included ascites, abdominal masses, abdominal enlargement, hepatomegaly, dyspnea, intermittent diarrhea, nausea, vomiting and weight loss. Clinically apparent infections and deaths have also been reported in several species of non-human primates from zoos and other institutions in Switzerland, Germany and Japan. In the primates, *E. multilocularis* cysts were found in the liver, as well as the lung, perirenal tissues, lymph nodes, abdominal cavity, spleen, pancreas and kidney.

Asymptomatic hepatic lesions have been reported in pigs and horses, as an incidental finding at necropsy.

Intermediate hosts – *Echinococcus vogeli* and *Echinococcus oligarthrus*

Infections with these two species have not been reported in domestic animal intermediate hosts. In pacas, *E. vogeli* does not seem to be symptomatic unless the cysts become very large.

Communicability

The definitive hosts can transmit echinococcosis to susceptible intermediate hosts, via eggs shed in the feces. *E. granulosus* becomes prepatent in 32 to 80 days in the definitive host. Although the parasites stop laying eggs after 6-10 months in dogs, the adult worms may survive for up to 3 years. *E. multilocularis* usually becomes prepatent in foxes

or dogs in 28 to 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. The adult worms are estimated to survive in the definitive host for approximately 5 months.

Intermediate hosts cannot transmit the infection to definitive hosts unless they are eaten, and unless their tissues contain mature cysts with protoscolices. Most *E. granulosus* cysts in sheep are fully infectious. Cattle are usually dead-end hosts for this species, as most of the cysts are sterile. *E. multilocularis* protoscolices mature to the infective stage in approximately 40 to 60 days in rodents. Intermediate hosts cannot transmit echinococcosis by casual contact.

Diagnostic Tests

Echinococcosis in the definitive hosts

The adult parasites, or their proglottids, can be found in the definitive host after purgation with arecoline compounds. At necropsy, either intestinal scraping or sedimentation and counting can be used to find the adults in the small intestine.

Routine fecal examinations are not reliable for diagnosis: *Echinococcus* eggs are nearly indistinguishable from other tapeworm eggs, and the proglottids are tiny and fragile, and usually go undetected. Infective material should be decontaminated, and protective clothing should be worn, to reduce the risk of human exposure during diagnostic investigations.

E. granulosus adults usually have 3 to 4 segments and are usually 3-6 mm long. Rarely, they may have up to 6 segments. The scolex has 4 suckers and a double row of 28-50 hooks, and is typically followed by a germinative neck region, one developing proglottid, one mature proglottid and one gravid proglottid.

E. multilocularis adults have 2 to 6 (usually 4-5) segments and are 1.2-4.5 mm long. The scolex has 26-36 hooks in a double row. *E. granulosus* and *E. multilocularis* are also distinguished by subtle differences in the mature proglottids. *E. oligarthrus* adults are approximately 2-3 mm long, and usually have 3 segments. *E. vogeli* adults are 3.9-5.6 mm long, and usually have 3 segments.

Commercial ELISA kits can be used to detect *Echinococcus* antigens from prepatent or patent infections in the feces. There may be cross-reactions with some other cestodes. A PCR-based assay can identify *E. multilocularis* eggs in the feces. Serologic tests are in development but are not currently used in the definitive host.

Echinococcosis in the intermediate hosts

In animal intermediate hosts, echinococcosis is mainly diagnosed at necropsy or, occasionally, at surgery. Metacystodes and protoscolices can be identified by histology. DNA techniques can also distinguish *Echinococcus* species or

strains using metacestode material. PCR can identify small or calcified *E. multilocularis* lesions. Ultrasound and other imaging methods may be helpful in some species.

Serologic tests are not generally used in domestic animals. ELISA tests can detect antibodies to *E. granulosus* in a percentage of infected sheep, but serologic diagnosis is complicated by cross-reactions with other species of taeniid cestodes, nonspecific binding of sheep antibodies by ovine HCF, and relatively poor *Echinococcus*-specific antibody responses.

Treatment

In the definitive host, *Echinococcus* spp. can be treated with a number of anthelmintic drugs including praziquantel and epsiprantel. Praziquantel is effective against both juvenile and adult *Echinococcus* parasites.

In intermediate hosts, surgery is the current treatment of choice. Long-term anthelmintic treatment may also suppress some *E. granulosus* and *E. multilocularis* cysts. Long term daily albendazole treatment, after surgical resection of the cyst masses, has effectively suppressed parasite growth in some dogs with *E. multilocularis* cysts.

Prevention

Infections can be prevented in dogs and cats by not allowing them to eat the carcasses, particularly the internal organs, of infected intermediate hosts. Dogs should not be fed raw offal from domestic or wild herbivores or pigs. In areas where *E. multilocularis* is a problem, cats and dogs should not be allowed to hunt and eat wild rodents. Regular examination and treatment of dogs, particularly sheep dogs, can decrease echinococcosis in domestic livestock. One-time treatment is not adequate; definitive hosts often become reinfected if they are re-exposed. Treatment of foxes with praziquantel in bait has been tried in some countries. An experimental recombinant vaccine has been developed for *E. granulosus* in sheep. Control and eradication programs are being carried out in some endemic regions.

Morbidity and Mortality

E. granulosus is common in dogs and livestock, where this disease is endemic and uncontrolled. More than 30% of dogs may be infected in some areas. Sheep are the most important intermediate host; in some parts of the world, the infection rate can be as high as 95%. Cattle, pigs and horses are infected less often. Cattle may have some innate immunity, as most *E. granulosus* cysts are sterile in this species.

E. multilocularis is less common than *E. granulosus* in domestic animals; however, it seems to be spreading into new geographic regions and its prevalence in domestic animals may be increasing. Currently, less than 1% of dogs and cats are infected overall, but as many as 12% of dogs are infected in parts of China and Alaska, and up to 7% of dogs and 3% of cats are infected in parts of rural Switzerland.

This parasite is more prevalent in wild predators; in endemic regions, from 1% to greater than 60% of foxes and coyotes are infected. However, transmission to humans is rare, even in areas where many wild canids are infected. The infection rates among domestic animal intermediate hosts are not well known. To date, few symptomatic infections have been reported. In Switzerland, *E. multilocularis* lesions were recently found, at necropsy, in 10% of feeder pigs kept outdoors. In eastern Switzerland, 2.9% of breeding sows had antibodies to an *E. multilocularis* antigen; three of the sows were necropsied and had multiple *E. multilocularis* lesions in the liver. In endemic regions, *E. multilocularis* metacestodes are found in approximately 2-10% of rodents.

The definitive host is rarely affected by infection with either *E. granulosus* or *E. multilocularis*. Most *E. granulosus* cysts in domestic animals also seem to be asymptomatic. Fatal *E. multilocularis* infections have been reported in intermediate hosts including rodents, dogs and non-human primates, but the morbidity and mortality rates are unknown. In most susceptible hosts, these tumor-like metacestodes are probably very dangerous, as they are not confined by a fibrous capsule and can metastasize. In pigs, the growth of *E. multilocularis* metacestodes appears to be suppressed.

Post-Mortem Lesions [Click to view images](#)

There are no lesions in the definitive hosts. Adult *Echinococcus* tapeworms vary from 1.2-7 mm in length, and are attached to the small intestine.

In the intermediate hosts, *E. granulosus* metacestodes are usually individual fluid-filled cysts, surrounded by a fibrous wall. Most are 1-7 cm in diameter but some cysts may reach 20 cm. Some cysts become calcified, necrotic or infected. Most of the cysts are found in the liver, and some in the lungs. Cysts can also be found in a variety of other internal organs, including the bones.

E. multilocularis metacestodes are initially found in the liver but can metastasize to other organs, particularly the lungs and CNS. These multilocular cysts have a semisolid matrix and resemble malignant tumors. They may be firm and lobulated or contain viscous fluid, and can contain many scattered transparent cysts of a few millimeters to centimeters in diameter. The center of the lesion may be necrotic. In pigs, *E. multilocularis* lesions are sharply demarcated, dense white foci of approximately 1-20 mm in diameter.

Internet Resources

Animal Health Australia. The National Animal Health Information System (NAHIS)

<http://www.aahc.com.au/nahis/disease/dislist.asp>

Centers for Disease Control and Prevention (CDC)

<http://www.cdc.gov/ncidod/dpd/parasites/alveolarechinococcosis/default.htm>

eMedicine.com
<http://www.emedicine.com/ped/topic648.htm>

FAO Manual on Meat Inspection for Developing Countries
<http://www.fao.org/docrep/003/t0756e/t0756e00.htm>

International Veterinary Information Service (IVIS)
<http://www.ivis.org>

Material Safety Data Sheets –Canadian Laboratory Center for Disease Control
<http://www.hc-sc.gc.ca/pphb-dgsp/msds-ftss/index.html#menu>

Medical Microbiology
<http://www.gsb.utmb.edu/microbook>

OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals
http://www.oie.int/eng/normes/mmanual/a_summry.htm

Review of Echinococcosis/Hydatidosis: a Zoonotic Parasitic Disease
<http://www.fao.org/docrep/t1300t/t1300T0m.htm>. Accessed 28 Oct 2004.

The Merck Manual
<http://www.merck.com/pubs/mmanual/>

The Merck Veterinary Manual
<http://www.merckvetmanual.com/mvm/index.jsp>

World Organization for Animal Health (OIE)
<http://www.oie.int/>

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