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A key role for veterinary authorities and animal health practitioners in preventing and controlling neglected parasitic zoonoses

A handbook with focus on *Taenia solium*, *Trichinella*, *Echinococcus* and *Fasciola*



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PREFACE

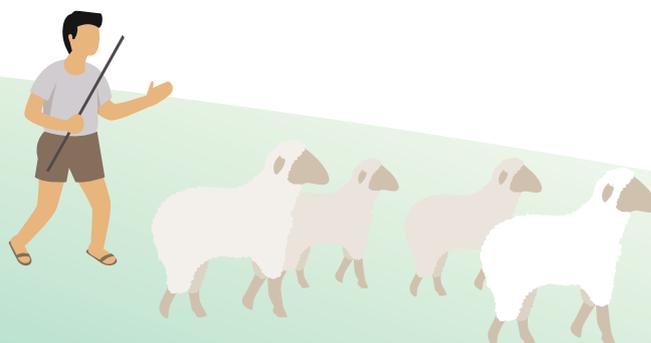
The Regional Offices of the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE) and the World Health Organization (WHO) in Asia and the Pacific region (“Regional Tripartite”) have a longstanding and successful partnership in promoting and facilitating a One Health approach to address challenges at the human-animal-environment interface, including zoonotic influenza, rabies and antimicrobial resistance. In October 2020, the regional representatives from the Tripartite organisations in Asia and the Pacific region signed a **Statement of Intent to Coordinate**. The statement acknowledged the importance of close coordination and effective communication across sectors, and expressed a commitment to working together to partner with the Member States and regional organisations to strengthen coordinated efforts to fight existing and emerging health threats, and to protect lives and livelihoods today and in the future.

Neglected parasitic zoonoses, such as cysticercosis and echinococcosis, are a group of zoonoses that continue to impose a significant burden and affect the livelihoods of vulnerable populations that typically have limited access to adequate sanitation, basic living conditions, health and veterinary services and awareness.

Recognising the disease burden and importance of a multisectoral approach to controlling and eliminating neglected parasitic zoonoses, in 2018 the Regional Tripartite jointly organised a **regional workshop on neglected foodborne parasitic zoonoses**, gathering representatives from different sectors, namely human health, animal health, food safety and water, sanitation and hygiene, and facilitating a dialogue to initiate joint coordinated actions. Following the meeting, the organisations continue to collaborate to enhance multisectoral partnerships at country level, ensuring that necessary multisectoral interventions reach all the affected populations in need, including hard-to-reach vulnerable populations, and to accelerate control and elimination of neglected parasitic zoonoses across the Asia and the Pacific region.

To control zoonoses in an efficient, effective and sustainable way, it is important to understand the transmission cycle of each disease and to implement strategic interventions at key stages via multisectoral participation from public health, animal health, environmental health and food safety. Prevention and control of infection in animals is one of the critical means to reduce the burden of zoonoses in humans, therefore the animal health sector has a very important role to play. However, awareness and knowledge are often limited among veterinary authorities, public health practitioners, animal health practitioners and animal owners.

This handbook focuses on interventions that the animal health sector can implement to prevent human and animal disease caused by these parasites. It aims to provide up-to-date information in a concise form and is expected to encourage the relevant stakeholders to take actions to control and prevent neglected parasitic zoonoses. Although the handbook was written primarily for Asia and the Pacific region, the information is relevant in many other regions. We hope you find this handbook useful and practical.



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Introduction

The effective and efficient control of zoonotic diseases, the diseases transmitted between animals and people, requires a One Health approach. One Health is a collaborative, multidisciplinary and multisectoral approach that can address health threats at the human-animal-environment interface in a way that is more cost effective, efficient and sustainable than might be achieved if all relevant sectors were not engaged [1]. A key sector in the control of zoonotic diseases is the animal health sector.

Neglected zoonoses

There are some zoonoses that are well known, due to their high mortality potential in animals and/or humans or because they might induce significant economic losses, such as avian influenza, henipavirus or severe acute respiratory syndrome coronavirus (SARS-CoV). There are other zoonoses that are often forgotten or overlooked because they cause mild or chronic disease, or in some cases no disease, in animals, the economic losses are not obvious, and they primarily affect the poorest people and marginalised communities. These diseases are called neglected zoonoses, and some examples are the diseases included in this handbook. The conditions in which people affected by neglected zoonoses live, such as the close proximity with their animals, limited or no access to healthcare services or clean water, and inadequate sanitation, promote the transmission of these neglected zoonoses (Figure 1), which have significant impacts on the people's health and livelihoods.



The objective of this handbook is to provide veterinary authorities and animal health practitioners with up-to-date information about the animal health tools available for prevention and control of some of the most neglected parasitic zoonoses, so they can ultimately help the vulnerable communities affected by these diseases.

Figure 1. Example of an environment in which neglected zoonoses thrive



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Role of the animal health sector

Although animals involved in transmission of neglected zoonoses are often not visibly affected, the animal health sector has a very important role in the prevention and control of these diseases. For neglected parasitic zoonoses, breaking the parasites' life cycle to interrupt transmission is essential, and the animal health sector is very well positioned to take the lead in implementing control measures, as the human health sector alone will not be able to achieve this aim. The animal health sector's role requires them to work together, using a One Health approach, in synergy with other relevant sectors, such as public health, to support the affected communities.

The animal health sector involves different actors: community/village animal health workers, animal extension workers and technicians, private veterinarians, official veterinarians, veterinary authorities, meat inspectors, traders of live animals and animal products, suppliers of animal feed and animal health products, policy-makers and others. This document is aimed primarily at veterinary authorities and animal health practitioners, in different roles within veterinary public health and the public and private animal health sectors, that might be involved in or are interested in the control of neglected parasitic zoonoses. The document also provides useful information for those involved in the control of

This handbook covers the diseases caused by the following parasites: *Taenia solium*, *Trichinella*, *Echinococcus granulosus*, *Echinococcus multilocularis*, *Fasciola hepatica* and *Fasciola gigantica*. Table 1 shows the different parasites, their hosts and the diseases they produce in humans and animals.

neglected parasitic zoonoses in other sectors including public health, WASH (water, sanitation and hygiene) and food safety to help them understand the need for a multisectoral One Health approach to solving the problem.

Given that these neglected parasitic zoonotic diseases usually affect the poorest communities, many interventions will be difficult to implement without technical and financial support, for example from local and central government authorities or international organisations. It is important that the different stakeholders are aware of the existing tools, so efforts can be made to make them available or to find alternatives and compromises.

Table 1. Parasites covered in this booklet, their hosts and the diseases they produce

Parasite	Definitive host*	Intermediate host**	Disease in humans	Disease in animals
<i>Taenia solium</i>	Humans 	Pigs 	Taeniasis and (neuro-) cysticercosis	Porcine cysticercosis
<i>Trichinella</i> spp.	Domestic and wild animals 	Domestic and wild animals 	Trichinellosis	Animals do not usually show clinical signs
<i>Echinococcus granulosus</i>	Dogs and wild carnivores 	Various mammals 	Cystic echinococcosis (hydatid disease)	Cystic echinococcosis (hydatid disease)
<i>Echinococcus multilocularis</i>	Foxes (and other carnivores) 	Rodents 	Alveolar echinococcosis	Multilocular cysts
<i>Fasciola</i> spp.	Mainly ruminants 	Aquatic snails 	Fascioliasis	Fasciolosis

* Definitive (final) host: the host in which the parasite reaches the adult stage and reproduces sexually.

**Intermediate host: the host in which the immature stages of the parasite develop.

1

Taenia solium



1. *Taenia solium*

How is the parasite transmitted?

- 1 The adult stage of the parasite *Taenia solium* is a tapeworm, 1-5 m long, that inhabits the human small intestine, causing taeniasis. Humans are the only definitive host (Figure 2). Nine to 10 weeks after infection, the tapeworm starts to release proglottids (sacs full of eggs).
- 2 The proglottids and tapeworm eggs are found in faeces of people with taeniasis. When a person with taeniasis defecates outdoors, this contaminates the environment.
- 3 When the tapeworm eggs present in the environment are eaten by pigs, the main intermediate host, the oncospheres (or embryos) are released from the eggs. The oncospheres are transported via the blood or lymphatics to different tissues (primarily skeletal and heart muscle, but also the brain). In approximately 8 weeks, each develops into a cysticercus; the infection is known as porcine cysticercosis. A cysticercus (commonly called a cyst) is an ovoid vesicle, 5-15 mm long, filled with clear liquid and containing the scolex (the head) of a tapeworm, which is seen as a white spot (Figure 3).
- 4 When a person eats undercooked or raw pork infected with viable cysts, they develop taeniasis and the parasite's life cycle is completed.
- 5 In a similar manner to pigs, humans can develop cysticercosis after ingestion of *T. solium* eggs, which mostly occurs via the faecal-oral route from close contact with a tapeworm carrier, or when they eat vegetables or drink water contaminated with the tapeworm eggs. In humans, the cysts are commonly located in the central nervous system, causing neurocysticercosis. Less frequently, cysts can also be located in striated muscles, subcutaneous tissue and the eyes.

Figure 2. Life cycle of *Taenia solium*

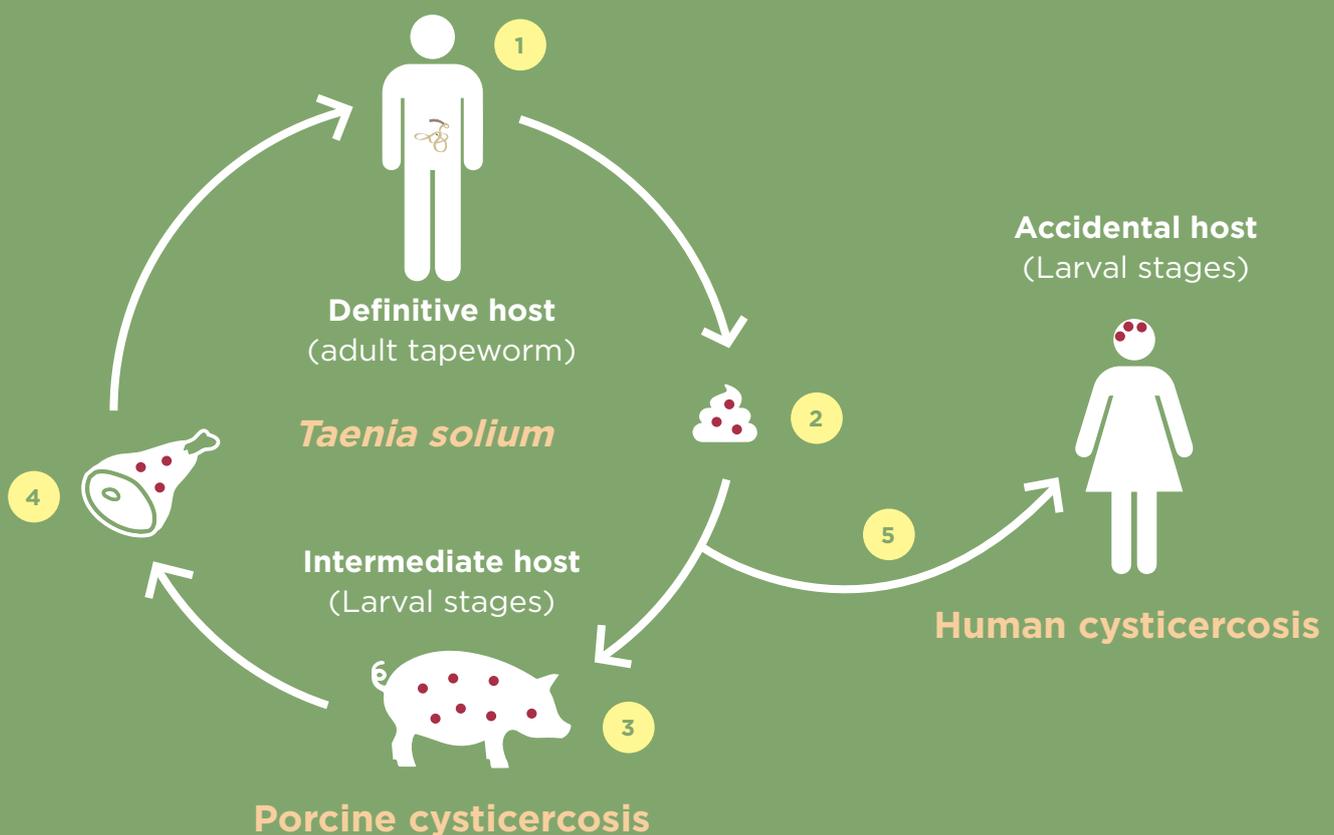


Figure 3. Left: A tapeworm cyst. Note the scolex, the white spot inside the cyst.
Right: Pork heavily infected with *T. solium* cysts.



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Geographical distribution

Taenia solium is endemic in many countries in Asia, sub-Saharan Africa and Latin America in communities in which pigs roam free and basic sanitation and hygiene practices are deficient.

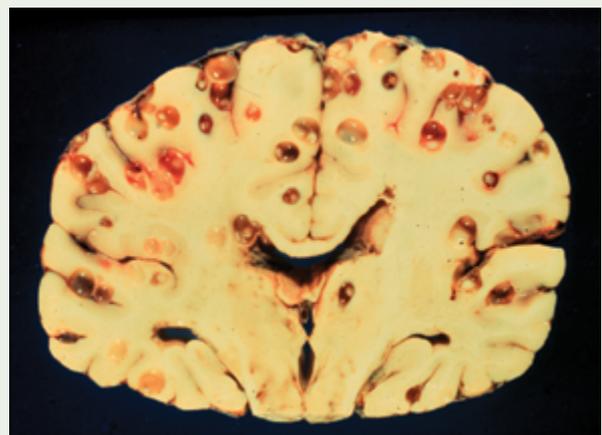
Why is the parasite important in humans?

Humans can develop two diseases with *T. solium*: when a person is infected by eating infected pork, they develop taeniasis; when a person is infected by tapeworm eggs, they develop cysticercosis. Cysticercosis in the central nervous system is called neurocysticercosis.

Taeniasis in humans is usually asymptomatic, and has no major medical significance.

However, neurocysticercosis is a very serious disease. The cysts in the brain (Figure 4) can cause seizures, epilepsy and other neurological disorders depending on the number, size and location of the cysts; the condition can also lead to death. Epilepsy is one of the most common manifestations of neurocysticercosis, and neurocysticercosis

Figure 4. Brain of a 12-year-old girl with multiple cysts



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is a major cause of adult-onset epilepsy [2]. In endemic communities, up to 70% of epilepsy cases have been associated with neurocysticercosis. Epilepsy causes social stigma, and affected people struggle to have a normal life. Epilepsy is very difficult to treat in poor and marginalised communities, which are the most affected. This disease is the reason why *T. solium* is a public health concern.

How are animals affected?

Usually, pigs do not show any clinical signs of the disease. The main impact of the disease is on human health. Only heavily infected pigs may show cysts under the tongue, as shown in Figure 5. In some instances, traders and butchers might inspect the tongues of pigs, and decrease the price if the pigs are infected.

How can porcine cysticercosis be diagnosed?

As mentioned above, tongue inspection (visual and palpation) conducted by an experienced person can be very useful. Only heavily infected animals (which are not usually the majority) can be detected, and sensitivity can be below 20%. Caution is required so as not to confuse the cysts with old scars or foreign bodies such as thorns, etc. However, tongue inspection is a very practical and inexpensive tool that can be used in the field. Serological tests are available, but they can have a high rate of false positives and often the majority of positive animals are not infected. The tests cross-react with other parasitic infections, such as *Taenia hydatigena* and *Taenia asiatica*. Post-mortem examination and detailed carcass dissection (slicing the meat every 3–5 mm) is considered the gold standard, but it is expensive and cumbersome [3].

Tools for public health prevention and control

There are many tools available for the control of *T. solium*, aimed at people, communities and pigs, and they are most effective when used in synergy under a One Health approach. They include:

- Treatment of people with tapeworm infections: this can be done at individual or community level, using a single oral dose of niclosamide or praziquantel.
- Prevention and control of infection in pigs: improved pig husbandry practices, vaccination, treatment and meat inspection (more details in the next section below).
- Water, sanitation and hygiene (WASH): activities that stop open defecation and promote efficient sanitation and better hygiene.
- Community awareness and education: to increase knowledge about the risk factors and prevention measures such as good hygiene, stopping open defecation and ensuring meat is properly cooked.

Figure 5. Heavily infected pig showing a *T. solium* cyst under the tongue



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Key role of veterinary authorities and animal health practitioners

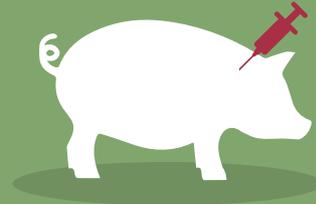
a) Live animals:

Pig management: Pigs in the poorest communities roam around the households and procure their own food in the surrounding areas because it is difficult for their owners to provide them with food. They become infected with *T. solium* by ingesting the tapeworm eggs present in human faeces or in the environment. Rearing pigs in pens prevents pigs from roaming, minimises the likelihood of pigs encountering tapeworm eggs and prevents the perpetuation of the transmission cycle. Veterinarians and animal health technicians can promote rearing pigs in pens. However, there are some considerations:

- i. Demonstrations might be needed to show farmers how to build pens using locally available material. The pens should be large enough for the number of pigs that are kept and should comply with the minimal animal welfare requirements (provision of clean water, ventilation, etc.).
- ii. If pigs are confined, farmers will have to provide food and water in sufficient quantity and quality. Farmers might need to be educated about locally available alternative foods of sufficient quality. The farmers can also be shown the benefit of using commercial feed, providing it is available in the area, affordable and cost effective.
- iii. Animals must be kept in pens for their entire lifetime, and not only at certain times of the year (such as during harvest) or in the fattening period when they are more valuable.

Pig vaccination: The vaccine containing the TSOL18 antigen is the only commercial vaccine registered for cysticercosis in pigs [4]. As of 2021, there is only one global manufacturer of TSOL18, Indian Immunologicals Limited (IIL), which trades the vaccine under the name of Cysvax®.

Vaccine dose: the TSOL18 vaccine is delivered as two doses of 1 ml each. The first dose can be given after 2 months of age. The second dose can be given between 1 and 4 months after the first vaccination [5]. Evidence from field evaluation of the vaccine suggests that this is sufficient to provide protection to pigs until slaughter age.



A combined approach applying both vaccination and oxfendazole treatment at the same time is advised, as this eliminates cysts that may be present at the time of vaccination and prevents the possibility of future infections.

The vaccine must be given intramuscularly (Figure 6); it is important to ensure that the vaccine is not given into the subcutaneous fat. The vaccine does not affect cysts that may already be present in a pig at the time of vaccination. For this reason, it is recommended that the animals are simultaneously vaccinated and treated with oxfendazole (see the point below).

Pig treatment: Oxfendazole is the drug of choice because it is the only drug that is effective at a single dose [6, 7]; other anthelmintics, including other benzimidazoles, are not appropriate.

Oxfendazole dose: 30 mg/kg. The drug should be administered orally, with cannulas or syringes, while the pigs are properly restrained (Figure 6). Given the dose required, to minimise the amount to be given to each pig, commercial products with concentrations $\geq 9.6\%$ are recommended.

Withdrawal period: the withdrawal period is the period in which animal products are not safe for human consumption after treatment. After treatment with oxfendazole at a dose of 30 mg/kg, pork is unfit for human consumption for **approximately 3 weeks after treatment** due to the drug residues [8]. In addition, it takes 4–8 weeks after treatment for the cysts to degenerate, and up to 12 weeks for the meat to have a clean appearance and appear suitable for human consumption.

The oxfendazole treatment does not prevent subsequent infection and only destroys cysticerci already present when the medication is given. Therefore, vaccination should be provided together with oxfendazole treatment (see the point above).

What to do when an infected pig is detected (for example at tongue inspection):

At the individual level:

- An individual pig can be treated with oxfendazole and after 2 months the meat should be safe to be consumed.
- However, the most important action is to identify whether there are more pigs at risk in the area, when wider control measures should be implemented.

At herd or village level:

- Vaccinate and treat all the pigs in the area. This can be done for example with the assistance of community animal health workers. Initially, the entire pig population can be vaccinated and treated, and afterwards the only pigs that need to be vaccinated and treated are young piglets, when they reach 2 months of age, and any pigs brought into the area (for example for fattening).

- It is important to implement adequate biosecurity measures to avoid spread of other diseases, especially when more than one community or village is involved.
- Do not forget to ensure that the (human) health authorities are aware of the presence of the disease in the area, so that combined One Health strategies can be implemented and impacts of interventions measured.

b) Meat inspection:

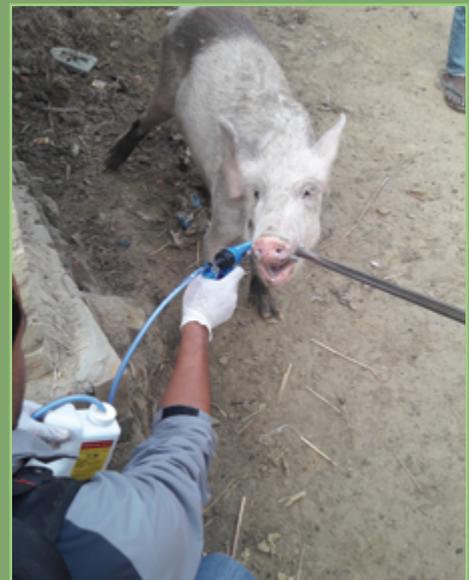
In many areas, pigs (especially those from backyard and small farmers) are not sent to commercial slaughterhouses, but are used for home consumption, or sold to the local butcher or the local market. Therefore, meat inspection should also be conducted in those places wherever possible (for example the local veterinarian can be asked to inspect the meat).

The effectiveness of routine meat inspection depends on the parasite load. Pigs with low numbers of cysts are not easy to detect; less than 30% of infected animals are detected at slaughterhouse inspection [9, 10]. Nevertheless, meat inspection is a practice that should be recommended because heavily infected animals can be detected and eliminated from the meat chain. The cysts are more commonly located in the masseter and other masticatory muscles, heart and

Figure 6. Pigs being vaccinated (left), and treated with oxfendazole (right) in Nepal.



@shah Poudel



@Keshav Sah



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tongue so multiple incisions should be made in those organs, as well as the shank and triceps if possible.

What to do when infected pork is detected:

- Follow the recommendations of the OIE standards (see below) and local legislation.
- Efforts should be made to trace the source of the animals, and the local health authorities should be informed so that control measures can be implemented in the area (as described above for a herd or village).
- The parasite can be killed at 60°C, but other pathogens require higher temperatures, so it is recommended always to cook pork at 71°C or above. The parasite can be killed by freezing pork at -10°C, but this may not be feasible in poor communities.

OIE international standards

- **OIE *Terrestrial Animal Health Code* - Chapter 15.4** - Infection with *Taenia solium* (porcine cysticercosis): Provides recommendations for prevention, control and surveillance of infection with *T. solium* in pigs. The aim of the chapter is to reduce the risk of infection with *T. solium* in humans and pigs and to minimise the international spread of *T. solium*.
- **OIE *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* - Chapter 3.10.5** - Cysticercosis: Provides internationally agreed diagnostic methods for the detection of infection with different Taeniidae including *T. solium* in pigs, and requirements for vaccines.



2

Trichinella spp.



2. *Trichinella* spp.

How is the parasite transmitted?

- 1 When a susceptible host eats muscle tissues with infective *Trichinella* larvae, the larvae are released within hours and burrow into the small intestine of the host. There are a very broad range of host species, including mammals, birds and reptiles (Figure 7). Within 2 days of infection, the larvae develop into adult parasites (approx. 0.5–3.5 mm long). Four to 7 days after infection, the adult female starts to release newborn larvae for a period of weeks until the host develops immunity, usually in less than a month.
- 2 The newborn larvae migrate into the general circulation and invade striated muscle cells, showing a predilection for specific muscle groups, which varies in the different host species. In pigs, these muscles are the diaphragm and tongue, followed by the masseter. The newborn larvae develop into muscle larvae (the infective stage) in about 15–20 days (Figure 8), and can remain infective for years. They remain infective for a considerable time even in decaying carcasses (which facilitates transmission by scavenging).

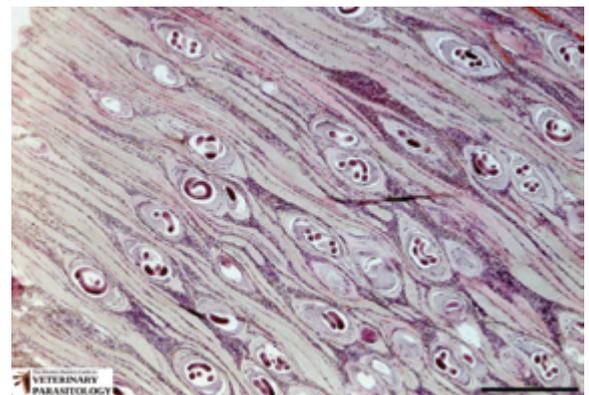
Different *Trichinella* spp. have a preference for different host species. The most common species infecting pigs is *Trichinella spiralis*. The majority of *Trichinella* spp. are considered infective for humans.

Pigs usually become infected by eating viable *Trichinella* larvae present in uncooked meat scraps or meat products, or infected carcasses of other pigs, rats, cats and other carnivorous wildlife. Humans usually become infected by consuming insufficiently cooked meat or meat products from an infected animal, commonly pork or wild boar, but also other animals such as horses, bears, lizards, etc.

Geographical distribution

Trichinella is found on every continent except Antarctica. Most *Trichinella* spp. have wide geographical and host distributions, but a few of them are found only in specific areas. *Trichinella spiralis* is present in temperate regions in Europe, Asia, New Zealand and North and South America.

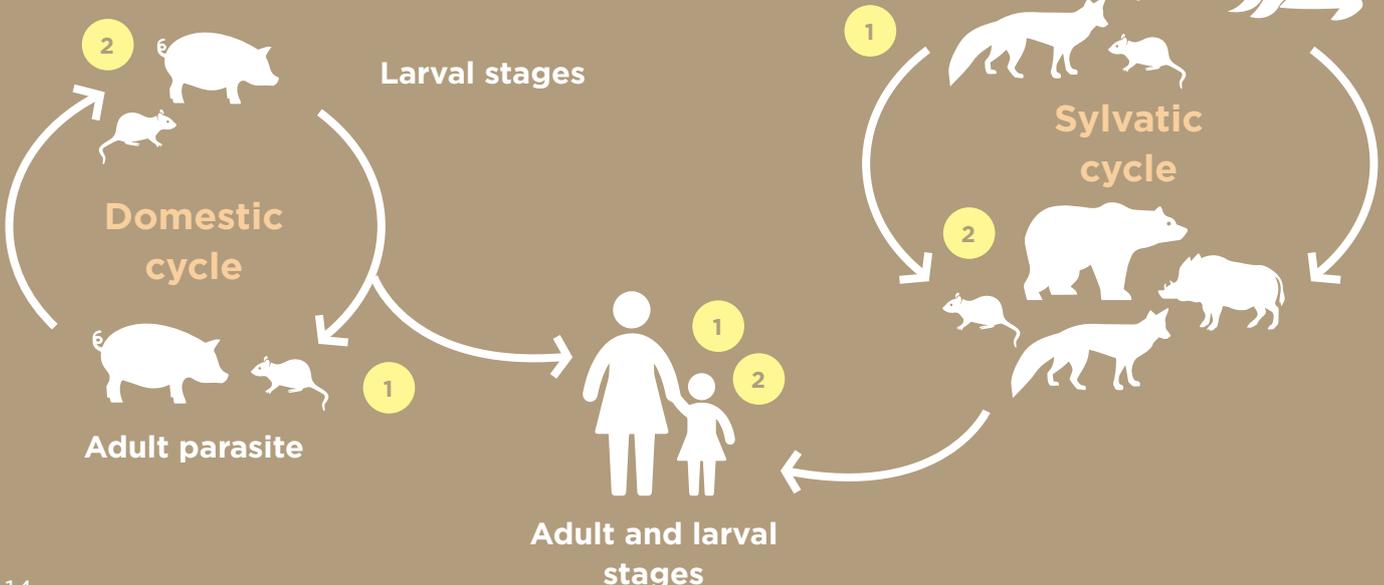
Figure 8. *Trichinella spiralis* encysted larvae in muscle



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Figure 7. Life cycle of *Trichinella* spp.

Trichinella spp.



Why is the parasite important in humans?

Human trichinellosis can be a debilitating disease and may result in death. However, many infected people have only light infections and do not show clinical signs. The parasites in the intestine can cause non-specific gastroenteritis with vomiting, abdominal pain and diarrhoea, but this is uncommon. The most severe signs are due to larval migration and depend on the number of infective larvae ingested. The migrating larvae can produce fever, muscle pain, oedema of the upper lids (a very common and prominent sign), severe headaches, excessive sweating and chills lasting several weeks. Though less common, diarrhoea and conjunctival and subungual haemorrhages can also be observed. More severe manifestations include heart disease and blood clots. A small number of patients with severe disease might have skin rashes, and respiratory and neurological symptoms.

How are animals affected?

Trichinella does not cause clinical signs in animals with natural infections and its main importance is as a human disease. In (high) experimental infections young pigs can show non-specific signs such as inappetence and diarrhoea. Adult pigs are more tolerant.

How can *Trichinella* be diagnosed in animals?

Tissue digestion and tissue compression (trichinoscopy) can be used to detect the larvae in tissues. To maximise sensitivity, the samples should be taken from muscle tissues in which the parasite has a predilection to encyst, which varies in different host species, such as the diaphragm pillars and tongue in pigs. Tissue digestion is the recommended method for individual carcass inspection. There are several digestion methods, but only approved methods should be used such as the ones described in the OIE *Manual* (see "Additional resources"). The International Commission on Trichinellosis recommends using 5 g of tissue for pigs in endemic countries [11]. The compression method is less sensitive.

Serology is also available but, due to the test's performance, it is recommended to be used for surveillance purposes, and not for individual carcass inspection.

Tools for public health prevention and control

These include:

- Prevention and control of infection in pigs: there are no vaccines available for *Trichinella* spp., and there are no effective treatments for the larval stages in animals. Albendazole and fenbendazole have been used in pigs to treat the adult worms in the intestine, although they are not adequately effective for cysts in muscle. The best strategy is to implement on-farm prevention including good pig-farming practices (more details in the next section below).
- Meat inspection (more details in the next section below).
- Community awareness and education: to increase knowledge about the risk factors and prevention measures such as good hygiene, washing hands with soap after handling raw meat, cleaning meat grinders after each use and ensuring meat is properly cooked.

Key role of veterinary authorities and animal health practitioners

a) Live animals:

Improved pig husbandry and management:

Improved pig management is the best tool to prevent pigs getting infected. Veterinarians and animal health technicians can promote and encourage farmers to implement good pig farming practices and biosecurity [11, 12]:

- i. Pig buildings/pens: ideally, pig buildings and pens should be constructed to prevent the presence of rodents as they play a key role in transmission (Figure 9). This might be difficult in certain settings, but measures should be taken to discourage rodents such as keeping the surrounding areas free from debris and rubbish where rodents can hide, nest or feed. The 1–2 m perimeter should have short vegetation (less than 10 cm high) or, ideally, pebbles or small stones (approx. 2.5–3 cm diameter). When possible, effective barriers between pigs and wild animals should be in place.
- ii. Rodent control: rat poison should only be used if other animals and children will not have access to the baits, and should only be used in places where other animals (such as cats or even the pigs) will not have access to the dead rats (such as external corridors).

iii. Feed and feed storage: all feed should be stored in closed containers if possible, and feed residues should be regularly cleaned up.

iv. Farm hygiene should include proper disposal of dead animals. All dead animals should be disposed of quickly and properly to avoid other pigs scavenging on them. Carcasses should be disposed of adequately [13].

v. If the local legislation allows pigs to be fed with swill (waste food and food scraps), this should be cooked properly according to local legislation (e.g. boiled for at least 30 minutes). Raw food waste of animal origin should not be fed to pigs.

Figure 9. Pigs living in environments that favour rats are at risk of getting infected with *Trichinella*



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b) Meat inspection:

Meat inspection is critical and a valuable method for the detection and condemnation of infected meat to prevent disease in humans. This can be conducted at slaughterhouses by tissue digestion tests (as mentioned earlier), and pooled samples can be used if an appropriate protocol is used.

What to do when infected pork is detected:

- Follow the recommendations of the OIE standards (see below), Codex Alimentarius and local legislation.
- If possible, the source of the animals should be traced, and the local health authorities should be informed, so control measures can be implemented in the source farm.
- The parasite can be killed by heating at 71°C or above for at least 1 minute (the meat should change colour from pink to grey throughout, so that the muscle fibres can easily be separated from each other). Curing, drying and smoking the meat are not adequate methods to kill

the parasite. Some species of *Trichinella* can be killed by freezing the meat (time and temperature requirements depend on the thickness of the meat cuts) but this does not kill all species and might not be feasible in poor communities.

OIE international standards

- OIE *Terrestrial Animal Health Code* – **Chapter 8.17** – Infection with *Trichinella* spp.: Provides recommendations for on-farm prevention of *Trichinella* infection in domestic pigs, and safe trade of meat and meat products derived from suids and equids. This chapter should be read in conjunction with the Codex Alimentarius Code of Hygienic Practice for Meat (**CAC/RCP 58-2005**) and Guidelines for the control of *Trichinella* spp. in meat of Suidae (**CAC/GL 86-2015**).
- OIE *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* – **Chapter 3.1.20** – Trichinellosis (infection with *Trichinella* spp.): Provides internationally agreed diagnostic methods for the detection of infection with *Trichinella* spp.

3

*Echinococcus
granulosus*



3. *Echinococcus granulosus*

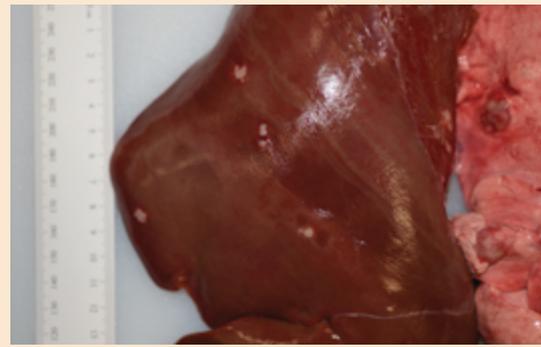
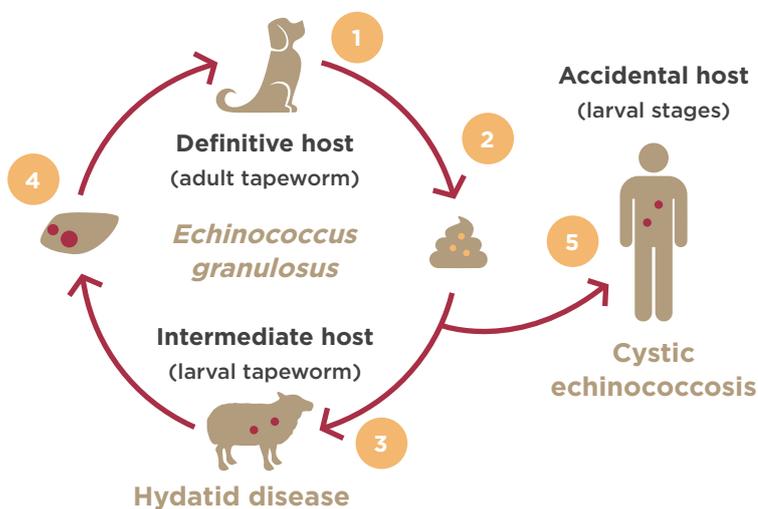
How is the parasite transmitted?

The parasite *Echinococcus granulosus* includes several genotypes (G) that differ in their preferred host species. The various genotypes, some of which are now considered separate species from *E. granulosus*, are collectively referred to as *E. granulosus sensu lato*. *E. granulosus sensu stricto* (which comprises G1, G2 and G3) is responsible for the great majority of disease in humans [14, 15]. The life cycle usually involves dogs as definitive hosts, and sheep as intermediate hosts (Figure 10). Cattle and other ungulates can also be intermediate hosts.

E. canadensis (previously known as *E. granulosus* genotypes G6, G7 and G10) is the second most important species infecting humans. The cycle usually involves, as intermediate hosts, camels and goats (G6), pigs (G7) and cervids (G8 and G10).

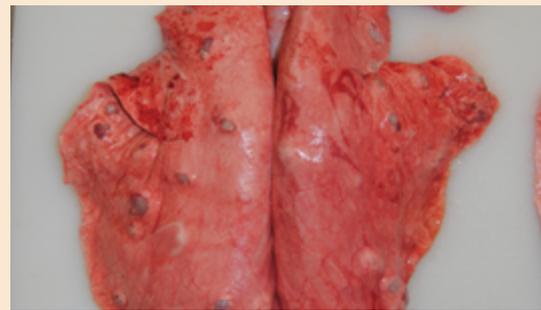
- 1 The adult parasite is a small, ~6 mm long, tapeworm that inhabits the small intestine of dogs or other canids (such as wolves, foxes or dingoes) which are the definitive hosts.
- 2 The infected definitive hosts release eggs in their faeces, which can survive for a year or more in the environment.
- 3 When the eggs are ingested by an intermediate host, the oncospheres (embryos) are released, which penetrate the intestinal wall and travel in the blood to the liver or via the lymph to the lungs. Hence, the liver and lungs are the most common organs in which the parasite settles

Figure 10. Life cycle of *Echinococcus granulosus*



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Figure 11. Two-year-old hydatid cysts in a sheep liver (above) and lungs (below)



©Marshall Lighthowers

(Figure 11). Occasionally oncospheres enter the systemic circulation and develop in other organs and tissues. The oncospheres develop into hydatid cysts (fluid-filled vesicles). Their growth is very slow, and it can take as long as a year for them to be easily visible. The cysts can contain one chamber or communicating chambers. In the liver and lungs, the cysts can reach a diameter of up to 30 cm, but when they are in other sites where unrestricted growth is possible, they may be larger and contain several litres of fluid. The infection with the cysts is known as cystic echinococcosis (CE) or hydatid disease.

- 4 When a dog or other canid eats offal of infected animals with fertile cysts, the tapeworms develop in the small intestine, and mature over a period of approximately 6 weeks, after which the tapeworms release infective eggs for a year or more. A dog can be infected with many thousands of *E. granulosus* tapeworms.
- 5 Similar to many other animals, humans can also develop CE after ingestion of *E. granulosus* eggs, which mostly occurs via the faecal-oral route from close contact with an infected dog.

Geographical distribution

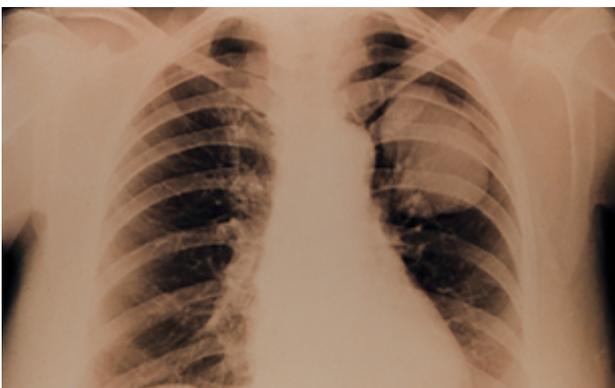
CE is globally distributed in most pastoral and rangeland areas of the world, with highly endemic areas in Central Asia, Siberia, western China, the eastern part of the Mediterranean region, northern Africa, southern and eastern Europe and at the southern tip of South America.

Why is the parasite important in humans?

In humans with CE, the cysts are commonly located in the liver and lungs, and less frequently in the bones, kidneys, spleen, muscles and central nervous system (Figure 12). The asymptomatic incubation period of the disease can last many years until hydatid cysts grow to an extent that triggers clinical signs, although many patients with CE have clinical signs within a few years of infection. The clinical signs vary depending on the number, size and location of the cysts. The size of the cysts is variable and usually between 1 and 15 cm, but much larger cysts with tens of litres of fluid have been described. Growth of a cyst may interfere with the function of the organ in which it occurs, worsening as the cysts enlarge, or cause pain. Spontaneous or traumatic rupture of CE cysts may cause anaphylaxis and death.

It is also possible for the cysts to calcify without any symptoms. Treatment options are often complex and may involve long periods with medication, percutaneous treatment or surgery depending on the size, location and stage of the cyst(s).

Figure 12. Patient with CE; X-ray showing a cyst in the lung



©Marshall Lightowers

Figure 13. Liver of an adult sheep heavily infected with hydatid cysts



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How are animals affected?

Typically, dogs with adult tapeworms do not show clinical signs. In the intermediate animal hosts, CE is typically asymptomatic. CE in farm animals causes economic losses due to condemnation of the offal infected with cysts (Figures 11, 13). There are also losses due to decreases in carcass weight, milk production, fibre production and fecundity. However, the main impact is on human health.

How can the infection be diagnosed in animals?

Presence of the adult parasite in dogs can be diagnosed by the detection of parasite eggs in faeces by microscopy techniques, but the eggs cannot be differentiated from the eggs of other *Echinococcus* or *Taenia spp.* Arecoline purging of infected dogs is no longer favoured because it is difficult to implement and poses an infection risk to people. Copro-antigen tests have been developed for research and some have limited commercial availability, although they may not have been adequately validated. For research purposes, copro-PCR (polymerase chain reaction) is also used.

In intermediate hosts, the most reliable method is post-mortem examination. However, it is important to differentiate hydatid cysts from the cysts of other parasites such as *Taenia hydatigena* which may also infect the liver. A limited number of studies have used ultrasound examination to detect liver hydatid infections in sheep. Serological techniques have been developed but their value is unclear – they are not in routine use.

Tools for public health prevention and control

There are several tools that can be used for public health prevention and control. They include:

- Prevention and control of CE in animals: avoid feeding dogs with offal, ensure the safe disposal of infected offal, treatment of dogs with praziquantel, and vaccination of livestock (more details in the next section below).
- Meat inspection: more details in the next section below.
- Water, sanitation and hygiene (WASH): provide a clean community water supply and promote good personal hygiene after contact with dogs.
- Community awareness and education: to promote the safe handling and disposal of offal, and to increase knowledge about the risk factors and prevention measures such as good hygiene, and prevention and control measures in animals.

Key role of veterinary authorities and animal health practitioners

a) Live animals:

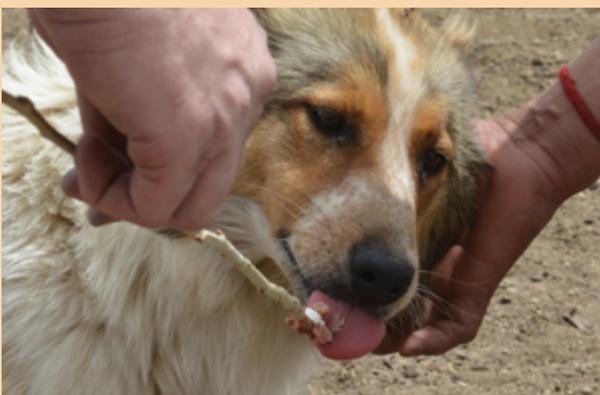
Dog management: many dogs are family dogs or working dogs and have owners, but in many cases there are also stray dogs that need to be considered. Veterinarians and animal health technicians can promote good dog management, including:

- Management of stray dogs (which will also have benefits for rabies control) as per the OIE *Code* (see “Additional resources”), including sterilisation of stray dogs.
- Avoid feeding offal to dogs; use commercial dry food if available. Cysts in offal can be inactivated by heating them to a core temperature of 80°C for 10 minutes, however, in rural settings with scarce cooking fuels, it may be challenging to cook the offal adequately. Cysts can also be inactivated by freezing to -20°C or below for at least 2 days. Note that these practices for inactivating the cysts might not be allowed by local legislation.
- Prevent dogs from scavenging on dead intermediate host species.

Dog treatment: the drug praziquantel is highly effective against the adult stages of *Echinococcus*; however, re-infection can occur after treatment. There is no vaccine against *Echinococcus* infection in dogs.

Praziquantel dose: praziquantel is usually given as a tablet at a dose of 5 mg/kg (Figure 14).

Figure 14. Dog being given a tablet of praziquantel with pâté to make it more palatable



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A combined approach implementing both dog treatment and livestock vaccination has been shown to be the most effective strategy.

Figure 15. Sheep receiving their booster vaccine



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Treatment frequency: treating dogs every 6 weeks is ideal because the time between infection and egg production is 42–45 days. In practice, this is often difficult to implement. Dogs in endemic areas should be treated at least every 3 months (4 times per year) [16]. Farmers can be reminded to deworm their dogs by radio announcements or even SMS, especially in remote areas, if technology allows. Dog treatment could be incorporated into other projects or campaigns that involve dogs, such as rabies vaccination or sterilisation campaigns.

Sheep treatment: there is no effective drug for treatment of hydatid cysts in intermediate hosts.

Sheep vaccination: the vaccine EG95 developed for use in sheep is highly effective [4] and can be used in other intermediate hosts that might be infected with *E. granulosus sensu stricto*. Currently, it is commercially produced in China and in Argentina.

Vaccine dose: the EG95 vaccine is delivered as 2 doses of 1 ml each, given subcutaneously (Figure 15). The vaccine has no effect on the



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cysts already present at the time of vaccination (and there is no effective treatment), so animals should be vaccinated when they are young, before they are likely to have become infected. Lambs should be vaccinated twice, 1 month apart, with the first vaccine around the time of weaning. A single additional booster vaccination when the animals are 1 year of age may be sufficient to provide adequate lifelong protection.

b) Meat inspection:

All livestock that are potential intermediate hosts for *E. granulosus* should be inspected at slaughter. Organs with hydatid cysts should be removed, condemned and disposed of, or processed according to the OIE *Code* (See “Additional resources”) and local legislation.

It is very important that contaminated offal is not fed to dogs so the transmission cycle is not perpetuated. In regulated commercial slaughterhouses contaminated offal is usually disposed of appropriately, but this might not be the case in small-scale or illegal slaughterhouses where it is easier to give offal to local stray dogs – this practice must be avoided. In many rural areas, sheep may be slaughtered locally by the farmers themselves or by local butchers. These individuals need to be made aware of the importance of not feeding contaminated offal to dogs.

What to do when infected offal is detected:

- Follow the recommendations of the OIE standards (see below) and local legislation.

- If possible, the source of the animals should be traced, and local veterinary authorities should be informed so that control measures can be implemented in the area (treatment of dogs, vaccination of sheep, community awareness).
- Ensure that the human health authorities are informed, so they can monitor the population and promote community awareness.

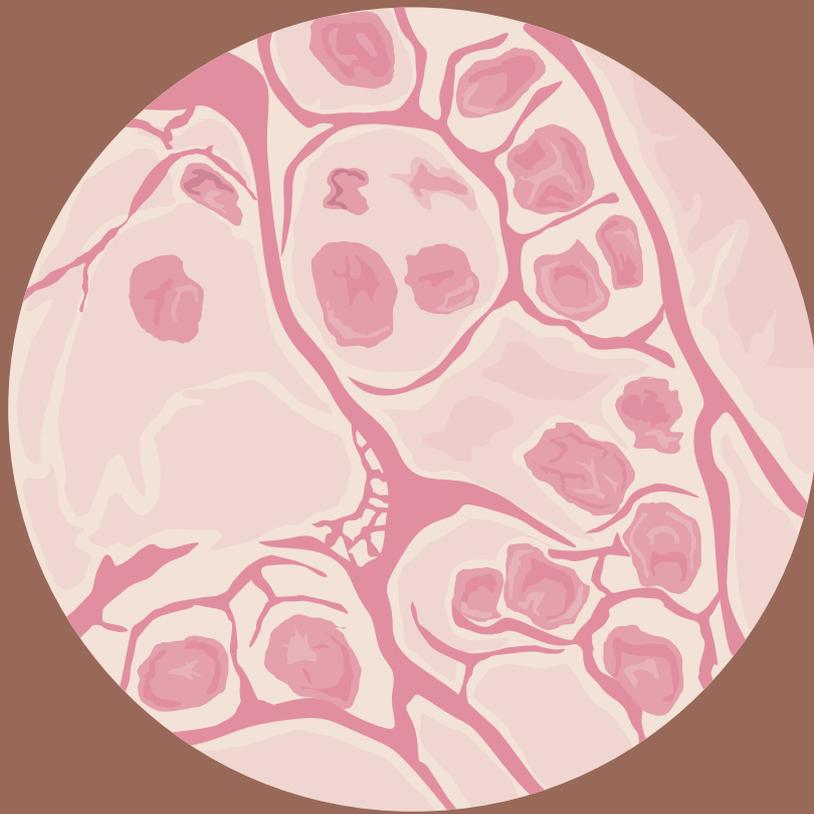
OIE international standards

- **OIE *Terrestrial Animal Health Code* – [Chapter 8.5](#) – Infection with *Echinococcus granulosus*:** Provides recommendations for prevention, control and surveillance of infection with *E. granulosus* in dogs and livestock.
- **OIE *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* – [Chapter 3.1.6](#) – Echinococcosis (infection with *Echinococcus granulosus* and with *E. multilocularis*):** Provides internationally agreed diagnostic methods for the detection of infection with *E. granulosus* and requirements for vaccines.



4

Echinococcus multilocularis



4. *Echinococcus multilocularis*

The parasite *Echinococcus multilocularis* has a transmission cycle mainly in wild animals.

- 1 Typically, the definitive hosts are foxes or other wild canids (Figure 16).
- 2 The intermediate hosts are a variety of small rodents such as voles. Domestic dogs and cats can also act as definitive hosts, becoming infected by ingesting infected rodents. Definitive hosts do not show clinical signs of infection with *E. multilocularis*.
- 3 Humans can become accidental intermediate hosts by ingesting parasite eggs released from an infected fox or other definitive host, for example by eating eggs present in fungi, berries and other plants that have been contaminated.

The cysts produced by the larval stage of *E. multilocularis* are quite different from those of *E. granulosus*. They develop rapidly and look like an alveolar structure of small vesicles up to about 3 cm in diameter (Figure 17). The disease in humans is called alveolar echinococcosis (AE). The cysts develop almost exclusively in the liver and form a tumour-like infiltrative and metastatic growth that can induce serious disease with high mortality. Left untreated in humans, the infection is fatal.

Figure 16. Life cycle of *Echinococcus multilocularis*

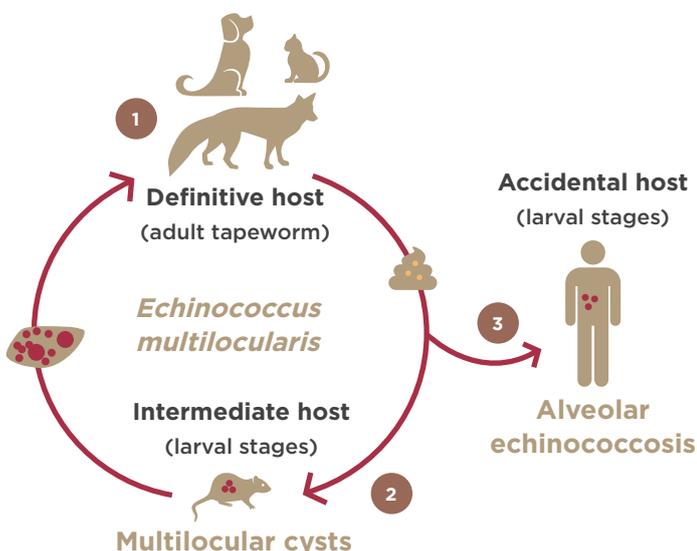
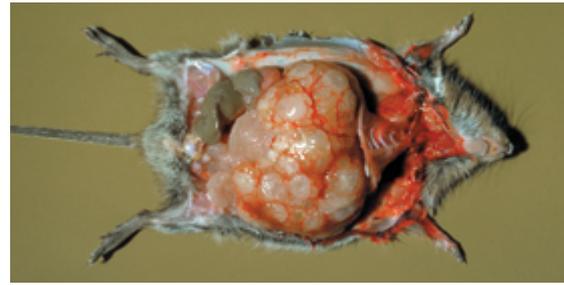


Figure 17. Rat 45 days after infection with *E. multilocularis*



©CDC/Dr Irving Kagan: CDC Public Health Image Library

Geographical distribution

AE is confined to the northern hemisphere, in particular to regions of China, the Russian Federation and countries in continental Europe and North America.

Key role of veterinary authorities and animal health practitioners

Given that the transmission cycle is mainly maintained by wild animals, there are limited actions that the animal health sector can take to prevent infection in humans. They include:

- Treatment of dogs and cats with praziquantel. Because the parasites reach maturity and start releasing eggs 30 days after infection, monthly treatment is recommended.
- Minimise opportunities for domestic dogs and cats to prey on wild rodents.
- Promote good personal hygiene such as washing hands after handling dogs or cats or being in the wild, farms or gardens where definitive hosts have access.

OIE international standards

- OIE *Terrestrial Animal Health Code* - [Chapter 8.6](#) - Infection with *Echinococcus multilocularis*: Provides recommendations for prevention, control and monitoring of infection with *E. multilocularis* in dogs, and monitoring in wild canids.
- OIE *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals* - [Chapter 3.1.6](#) - Echinococcosis (infection with *Echinococcus granulosus* and with *E. multilocularis*): Provides internationally agreed diagnostic methods for the detection of infection with *E. granulosus* and *E. multilocularis*.

5

Fasciola hepatica
and *Fasciola*
gigantica



5. *Fasciola hepatica* and *Fasciola gigantica*

How are the parasites transmitted?

- 1 The adult stages of the parasites *Fasciola hepatica* and *Fasciola gigantica* are flukes that live in the bile ducts in the liver of the definitive hosts (Figure 18). The definitive hosts are mainly domestic ruminants (buffalo, cattle, goats and sheep). Wild ruminants and other mammals such as deer, wild boar, rabbits, horses and donkeys can host the adult parasite. It can also infect grazing pigs, and occasionally infect humans.

Adult *F. hepatica* can measure 3.5×1 cm, and *F. gigantica* 7.5×1.5 cm (Figure 19). There are also hybrid forms between these two species that are referred to as *Fasciola* “intermediate forms”.

The life cycle takes around 14–23 weeks [17].

- 2 The adult flukes lay eggs that reach the intestine via the bile and are eliminated in the faeces of the definitive host.
- 3 After 2 weeks and under the right environmental conditions, the eggs hatch to release a motile miracidium (juvenile stage) which locates and invades the snails that act as intermediate hosts.

Figure 18. Life cycle of *Fasciola* spp.

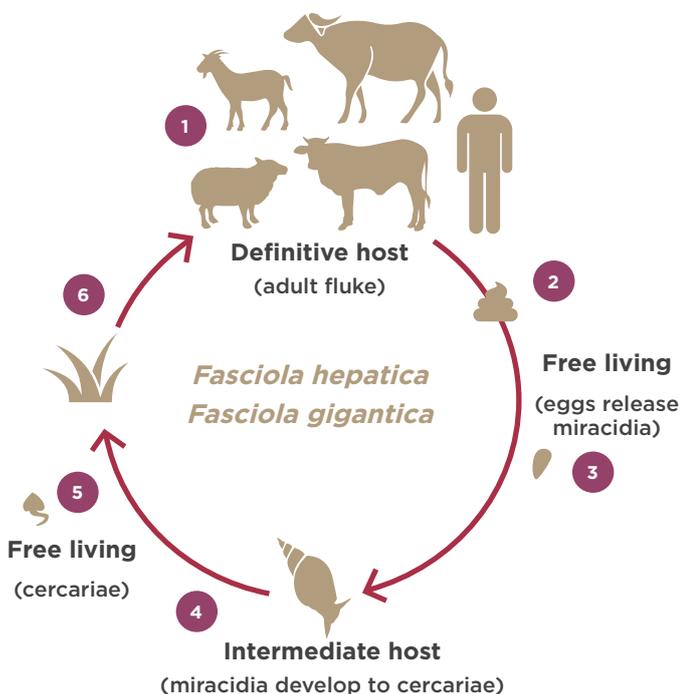


Figure 19. *Fasciola hepatica* in a bovine liver



©Barros, Noah's Arkive.

Figure 20. *Austropeplea tomentosa*, an example of an aquatic snail intermediate host for *Fasciola hepatica*



©Marshall Lightowers/Charles Gauci.

- 4 Several species of aquatic or amphibious snails of the family Lymnaeidae (Figure 20) act as intermediate hosts. The miracidia go through several stages of development in the snail, and finally after 3–7 weeks they develop into cercariae.
- 5 The cercariae leave the snail (often when more water is available such as after rain), swim in the water and often attach themselves to water plants, where they encyst, forming metacercariae.
- 6 The metacercariae measure about 0.2 mm. Their survival depends on the environmental conditions and, under appropriate conditions, they can live for up to a year. The definitive hosts become infected by eating a plant with metacercariae or drinking water containing metacercariae. Once the parasites are eaten, they are released in the intestine and migrate until they reach the liver, where they mature. They can live for up to 11 years in sheep, 1 year in cattle and 9–13 years in humans.

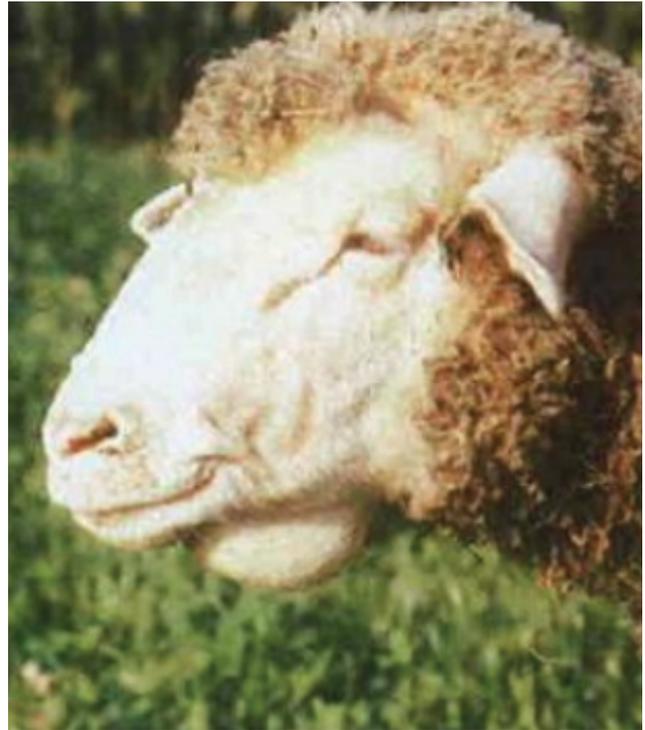
Geographical distribution

Fasciola hepatica is present on all continents except Antarctica. *Fasciola gigantica* is mainly found in tropical and subtropical regions of South Asia, Southeast Asia and Africa.

Why is the parasite important in humans?

People usually become infected by ingesting metacercariae present on aquatic plants (typically watercress and other freshwater plants) or in water. They can also become infected by eating raw livers infected with migrating juvenile flukes, because the parasites can continue their migration after being ingested [18]. Symptoms of fascioliasis in humans depend on the parasite burden and the duration of the infection. Many people with light infections do not have any symptoms. In the acute stage, the young parasites migrate through the liver and may cause traumatic, allergic and inflammatory lesions, with the severity depending on the number of parasites. The most common symptoms are abdominal pain and fever, loss of appetite, nausea and diarrhoea. In the chronic or obstructive period of the infection, inflammation of the bile ducts and the presence of the parasite may lead to obstruction of the bile ducts. The most common signs are biliary colic, intolerance of fatty food, nausea, jaundice and right-upper-quadrant abdominal tenderness. In some cases, the condition may evolve to cirrhosis. Repeated infections can occur in endemic areas, so acute and chronic symptoms may be observed simultaneously. There is an increasing number of human case reports in many countries. A high prevalence of fascioliasis in humans does not seem necessarily related to high prevalence in animals [17].

Figure 21. Sheep with bottle-jaw oedema due to chronic fasciolosis



©Liver fluke disease in sheep and cattle:
NSW Department of Primary Industries.

How are animals affected?

Sheep are one of the most affected species; cattle seem less affected and clinical disease is usually only seen in young cattle. Horses and pigs are relatively resistant. The disease may be acute, sub-acute or chronic. Acute disease occurs when large numbers of the parasite have been ingested and they migrate through the liver, causing extensive destruction; there can be outbreaks and sudden deaths. The surviving animals are weak, pale and sometimes present with enlarged livers, abdominal pain and ascites.

In the sub-acute disease, the parasites are eaten over a long period of time, so some parasites are already in the liver while others are migrating. Rupture of the liver is rare. Sheep may show severe anaemia and, if not treated, the condition can lead to death.

Chronic disease is the most common form seen in sheep, goats and cattle, and particularly in more resistant hosts such as horses and pigs. Clinical signs manifest 4–5 months after ingestion of the parasites. There is anaemia, a progressive loss of condition, decreased appetite, submandibular oedema (known as bottle-jaw) (Figure 21) and ascites. In cattle there is also calcification of the bile ducts and enlargement of the gallbladder.



Fasciolosis is mainly a disease of animals that occasionally occurs in humans.

The disease in animals is important, not only for the production and economic losses, but also because livers are condemned at meat inspection and are not allowed to be used for human consumption. In some areas, this may be quite important to the local communities for economic or cultural reasons.

How can fasciolosis be diagnosed in animals?

The diagnosis is based primarily on clinical signs, seasonal occurrence, previous history of fasciolosis in the area or identification of snail habitats, but these are not always reliable. Typical *Fasciola* eggs can be identified and counted in faecal samples from infected animals. The eggs can be identified using more advanced techniques such as ELISA (enzyme-linked immunosorbent assay) and copro-antigen tests, though these may be not available in basic laboratories in developing countries.

Tools for public health prevention and control

The tools for the control and prevention of fasciolosis need to be considered and adapted to the local context, as epidemiological situations can be different (Figure 22). They include:

- Prevention and control of infection in livestock: treating animals with anthelmintics and using adequate management practices such as rotational grazing (more details in the next section below).
- Treatment of human fascioliasis: people can be treated for adult flukes using triclabendazole. This can be done with community-wide interventions when there is high prevalence, or by targeting the highest prevalence groups such as school-aged children if appropriate.
- Water sources: taking measures to prevent faecal contamination of areas where intermediate hosts may be present, such as aquatic vegetable-growing areas. Snail control can also be implemented; there are several options including physical, chemical and biological methods. Many chemical treatments (molluscicides) are not recommended or allowed because they may damage the environment.

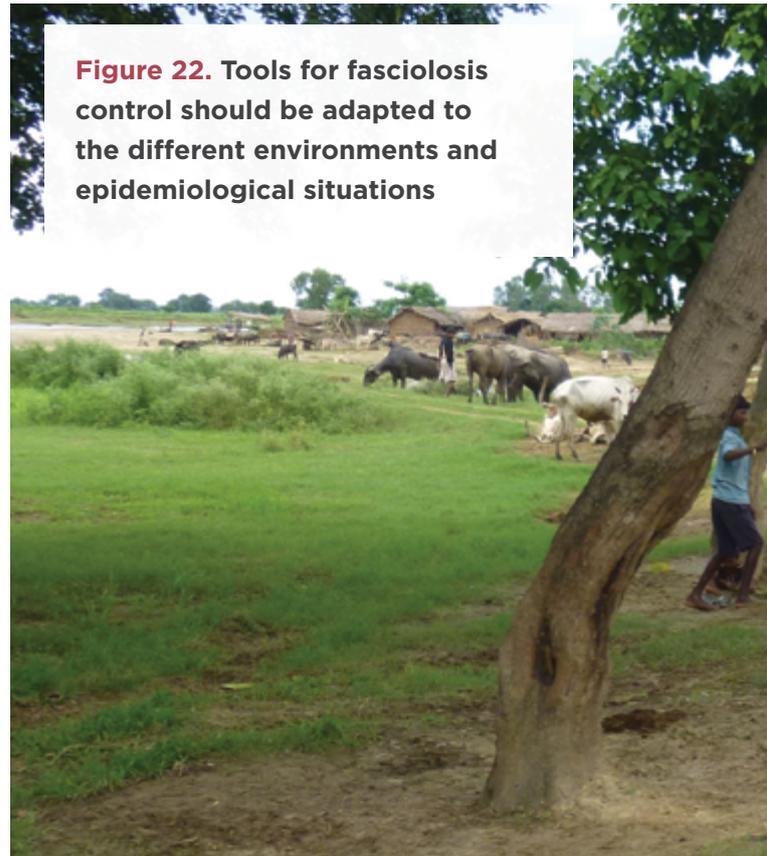


Figure 22. Tools for fasciolosis control should be adapted to the different environments and epidemiological situations

- Water, sanitation and hygiene (WASH): introducing activities to promote drinking safe water, efficient sanitation, use of latrines and reduction of faecal contamination of water sources.
- Community awareness and education: increasing knowledge of the risk factors such as eating uncooked freshwater plants and raw liver. People should avoid eating raw aquatic vegetables harvested from or near grazing lands or where there could be faecal contamination. Rinsing the vegetables is not sufficient. The parasite can be killed by cooking the vegetables at 60°C for several minutes. Many chemical products such as potassium permanganate, citric acid and acetic acid have been suggested, but their effectiveness varies depending on the concentration of the agent and duration of application. These chemical products may cause the parasites to be detached from the vegetables but not killed, and in general the parasites seem highly resistant. Freezing vegetables is not recommended. Water can be boiled or filtered. Livers should be cooked thoroughly.



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Key role of veterinary authorities and animal health practitioners

a) Live animals:

There are no vaccines available. Livestock treatment and management are the best control measures, in conjunction with other measures such as environmental control of the snail host.

- **Livestock treatment:** Treating livestock with anthelmintics at strategic times is very important.

Available drugs: Currently there are 7 drugs effective against *Fasciola*: albendazole, triclabendazole, nitroxinil, closantel, oxclozanide, rafoxanide and clorsulon [19]. Most are not effective against all stages of *Fasciola*, and sometimes combinations are used. Efficacy may vary in different species, for example oxclozanide is highly effective against adult flukes in sheep, but not in cattle. The best drug is triclabendazole, which is effective against immature and adult parasites. Unfortunately, in many areas there is resistance to triclabendazole. Additionally, because triclabendazole is the drug of choice for

humans, it should not be used in areas where the disease is common in humans, to minimise the risk of resistance. Given the variations in drugs and increased drug resistance, it is important to follow the national guidelines regarding the drug of choice and treatment regimes.

Route of administration and dose: Of the drugs available, some are given orally, some are injectable and some applied percutaneously, and the doses vary. The use of triclabendazole in molasses blocks has been tried, and has been suggested where facilities for animal restraint to enable delivery of oral anthelmintics are not available. All drugs should always be used as indicated by the manufacturer.

Drug selection: Besides availability, drugs should be selected based on the stage of infection and the productive stage of the animal, which will affect the withdrawal period (see below). To avoid resistance, the use of drugs with different mechanisms of action, either in rotation or in combination, is often recommended.

Withdrawal period: The withdrawal period is the period during which animal products are not safe for human consumption after treatment, and will vary depending on the drug and the animal product. The withdrawal periods after treatment can range from a few days to months. In dairy cows, during lactation, only drugs with very short withdrawal periods (usually up to 7 days) are recommended, as the milk is not safe for human consumption and should be discarded [19].

Strategic treatments: The number of treatments per year and the timing depend on the transmission patterns, the severity of the problem and the animals to be treated (usually cattle require fewer treatments than sheep). Transmission dynamics in the local area are key factors, and infection can be year-long, or have 1 or 2 transmission seasons depending on how snails are influenced by the climate and weather, cattle movements, irrigation practices, etc. It is very important that treatment times are adapted to local circumstances. For example, it has been proposed to use only 1 treatment in May in cattle in the riverbanks area of Cambodia [20]. In areas with 2 transmission seasons, 3 or 4 treatments per year may be recommended.

Some considerations:

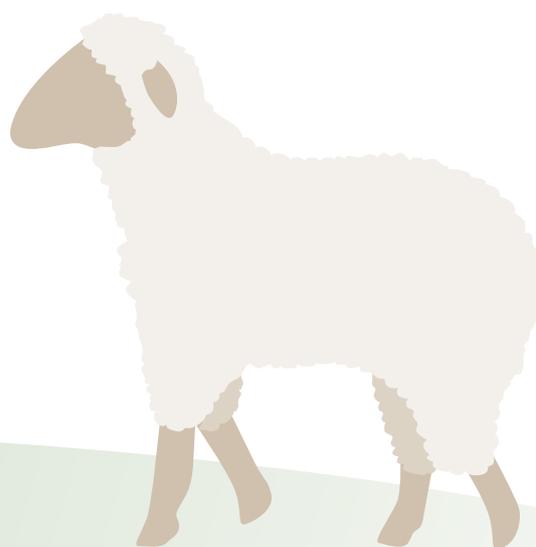
- Drugs that are not effective against immature flukes are not recommended in acute outbreaks.
- Ideally, the efficacy of the treatments should be assessed by faecal egg count or other tests if available.
- Report to the authority responsible for veterinary medical products if there is drug resistance, especially with triclabendazole. Human health authorities should also be notified if triclabendazole resistance is observed.

Livestock management:

- If possible, animals should not be allowed to access wet grazing areas suspected to be *Fasciola* infested, especially the most susceptible livestock species (sheep, goats, and young cattle).
- Grazing on swamp pastures should be avoided to reduce the risk of the grazing animals encountering metacercariae and to reduce the contamination of snails with faeces of infected animals.
- Biological control using free-range ducks to control snails carrying *Fasciola* is a potential practical control option.
- Alternatively, other measures such as rotational grazing, only allowing grazing in suspected areas for a limited period of time (6 weeks), can be used in combination with strategic treatment. The feasibility of this strategy depends on the available grazing areas and the number of animals.

b) Meat inspection:

Infected livers should be discarded and not allowed to be used for human consumption.



6

Practical recommendations for veterinary authorities and animal health practitioners



The animal health sector, including veterinary authorities and animal health practitioners, plays a very important role in the prevention and control of neglected parasitic zoonoses.

Table 2 and Figure 23 summarise the specific tools available for the animal health sector to control some selected neglected zoonotic parasites.

Table 2. Tools available for the control of selected neglected zoonotic parasites

AH intervention Parasite	Awareness & education*	Improved animal management	Treatment definitive host	Treatment intermediate host	Vaccination intermediate host	Meat inspection
<i>Taenia solium</i>	✓	✓	(Human public health**) ✓	✓	✓	✓
<i>Trichinella</i> spp.	✓	✓				✓
<i>Echinococcus granulosus</i>	✓	✓	✓		*** ✓	✓
<i>Echinococcus multilocularis</i>	✓		Only domestic hosts ✓			
<i>Fasciola</i> spp.	✓	✓	✓			✓

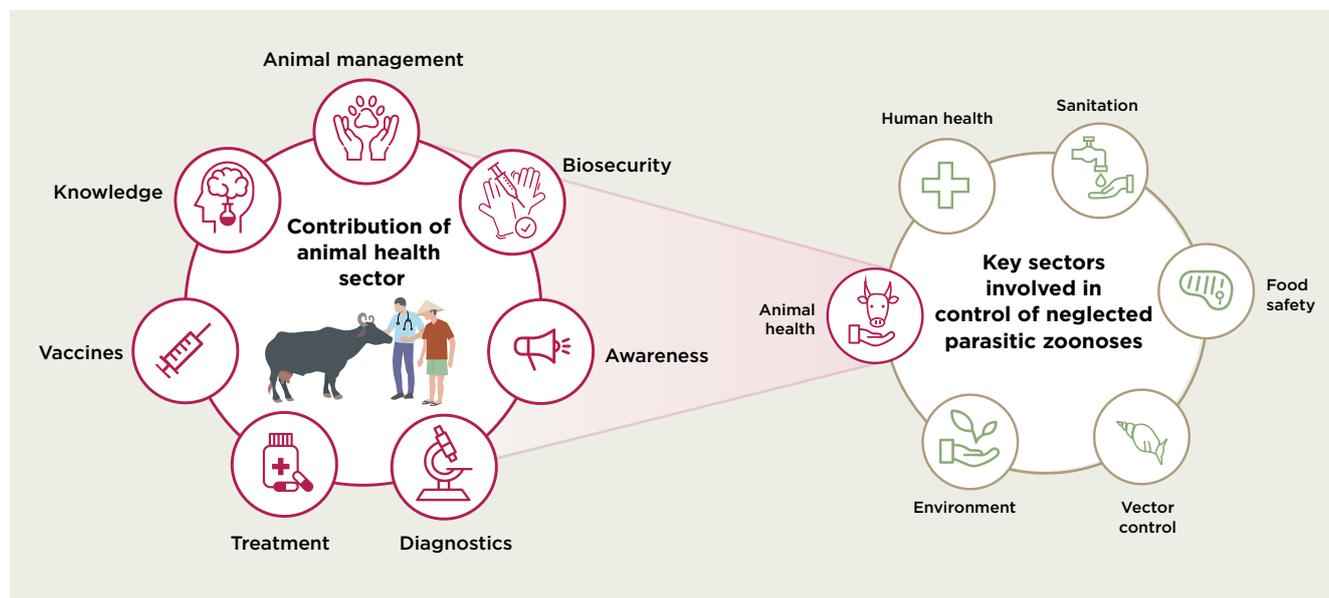
AH: animal health

* Focus on animal owners but could include the entire community.

** Not an animal health tool, but included for completeness.

*** Vaccine effective for sheep and any intermediate host that might be infected with *E. granulosus sensu stricto*.

Figure 23. Different sectors should work together for better control of neglected zoonoses under a One Health approach. The animal health sector can contribute with different tools



Some of the generic activities that veterinary authorities and animal health practitioners can contribute to the prevention and control of neglected parasitic zoonoses include:



1. Surveillance for the identification of neglected zoonotic diseases

Surveillance activities can be informed by the identification of human or animal cases. Active surveillance should be implemented if diseases are suspected in the area.



2. Planning and implementation of veterinary public health interventions

Planning and implementation of public health interventions for the control of confirmed neglected zoonoses, in collaboration with other sectors as appropriate, may include the points mentioned below (3-9) as appropriate.



3. Creation of public awareness

- Field veterinarians (official and private veterinarians) can train and refresh or update the knowledge of animal health technicians and community animal health workers. It is very important that all “field” animal health workers who are in contact with animals, and with animal owners and farmers, are up to date, and know how to proceed when there is a suspicion or confirmation of a disease.
- Community animal health workers, animal technicians and field veterinarians can create awareness among animal owners and farmers in their day-to-day activities, while in contact with animal or livestock owners.
- All animal health practitioners can contribute to creating awareness before and during control programmes, including vaccination campaigns, to ensure high coverage of the vaccine and increase willingness to participate among animal owners, farmers, community leaders, etc.
- Create awareness through special events, for example talks during market days, radio interviews, talks at primary and secondary schools or mothers’ groups. It is important to include community leaders such as village chiefs and teachers. Facilitate poster displays in public places such as village meeting halls and schools.
- Animal health authorities can also create awareness with policy-makers and other relevant authorities.



4. Biosecurity implementation and advice

- Different biosecurity measures are relevant depending on the species of animal involved, the type of sector (for example backyard or commercial farms) and the local circumstances and risks such as the presence of other diseases in the area. For example, if there are outbreaks of important highly infectious diseases such as foot and mouth disease or African swine fever in the area, biosecurity measures become more significant.

- During vaccination campaigns, it is very important that basic biosecurity measures are implemented, such as thoroughly washing and disinfecting hands, boots/shoes and any material or equipment used to restrain the animals when going from village to village (and, if possible, from household to household, Figure 24). When working in remote and difficult settings where there are restrictions in implementing the ideal biosecurity measures (for example, disinfectant not available), ensure that a contingency plan is in place (bring your own disinfectant), or use other measures to minimise the risk of disease transmission (wash with detergent and expose to the sun). All those involved from the animal health sector should discuss the minimum and ideal biosecurity measures to be implemented in the field.
- On-farm biosecurity is very important. This includes a variety of measures, from good hygiene practices and rodent control to confining the animals and minimising potential contact or exposure with infected (domestic or wild) animals. Animal health technicians and veterinarians should be able to advise farmers and other animal owners on the implementation of the key biosecurity measures.
- If the ideal biosecurity measures cannot be implemented, this is not an excuse to implement no biosecurity measures and personal hygiene practices at all – always try to minimise the risks!
- If there is any relevant legislation concerning biosecurity, it should always be followed.
- More detailed information for pigs is available in the booklet “Good Practices for Biosecurity in the Pig Sector” [12].



5. Providing advice on good animal management and farming practices

- This can include a variety of topics, from pasture management so the animals do not have access to risky grazing areas, to activities such as fencing to minimise contact with intermediate hosts. Animal health technicians and veterinarians should be able to help livestock owners in identifying the appropriate measures and practices.
- Good management and farming practices include good biosecurity practices (see above).
- Any legislation regarding animal welfare, animal management and farming practices (including legislation on topics such as antimicrobial use and food safety) should always be followed. Animal health technicians and veterinarians should be aware of the legislation, and ensure it is followed.



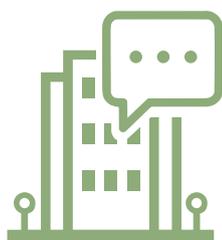
6. Making prevention and control measures feasible for local farmers

The ideal preventive and control measures for neglected zoonoses might be difficult for livestock owners to implement, for example because they may not be able to afford such measures and resources are scarce, which is usually the case when dealing with neglected zoonoses. The veterinary authorities and animal health practitioners should work with farmers and other animal owners to find solutions that are feasible and practical, or compromises that are acceptable.



7. Communication within the animal health sector

- It is critical that there is a functional communication chain within the animal health sector. For example, if a community animal health worker or an animal technician identifies a zoonosis, he or she should ensure that the local official veterinarian is aware. At the same time, the local official veterinarian should ensure that the regional veterinarian (or equivalent) is informed, so the veterinary authorities can be made aware of the problem.
- Communication should also work in the other direction, so if, for example, a relevant new policy is set up, communication within the sector flows so that all field animal health workers have access to up-to-date information and are aware.
- Communication between coordinators of different control programmes can lead to important synergies at field level. For example, when restraining dogs for rabies vaccination the dogs can also be dewormed, or the logistics for a classical swine fever vaccination campaign (or for another animal disease) in areas where porcine cysticercosis is present can also be used for porcine cysticercosis vaccination. In cases where timings of vaccinations do not coincide, the same cold chain can be used.
- Communication between official and private field veterinarians can also create important synergies, ensuring that private veterinarians are aware of the diseases present in the area, and the control measures that are being implemented, so that they can answer questions when asked by their clients and even support and participate in the control efforts.



8. Communication with other sectors

- When a zoonosis is identified, it is imperative that the human health sector is aware so that they can take the appropriate actions within their sector, and be better prepared to prevent the disease and manage patients.
- Communication within sectors will be more effective when it happens at different levels simultaneously. For example, the local veterinarian can communicate with the local primary health centre while the veterinary authorities communicate with the human health authorities.
- Communication with other sectors should be proactive and include all the relevant sectors.



9. Adequate policies

- Veterinary authorities can ensure that the local legislation and policies are appropriate to deal effectively and efficiently with the prevention and control of neglected zoonotic diseases, and provide a supportive framework for their implementation.
- Neglected zoonoses usually affect the poorest communities which may struggle to implement control measures; hence, policies might include support and incentives for livestock keepers and animal owners, if feasible and appropriate.
- Veterinary authorities can also liaise with other authorities (such as human public health, environment, etc.) to ensure that the policies in the different sectors work in synergy and are coordinated towards the aim of controlling neglected zoonoses.

Figure 24. Equipment used to restrain animals (such as pig snares) should ideally be disinfected between households



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The animal health sector can play and should play a very important role in the control of neglected parasitic zoonoses.

Field veterinarians and other animal health practitioners are best placed to:

- create awareness among farmers, animal owners and the community
- identify disease in animals and alert the owners and the veterinary and human health authorities
- guide animal owners on how to prevent and control disease
- ensure preventive and control measures are adapted to the local circumstances, including local management practices and epidemiological conditions

- ensure the recommended preventive and control measures are feasible for the local livestock keepers and animal owners.

Veterinary authorities can play a key role by:

- establishing surveillance programmes
- conducting awareness campaigns
- setting up and supporting national/sub-national control programmes
- liaising with human health authorities and other authorities as required
- providing a conducive policy environment.

Additional resources

- [OIE Terrestrial Animal Health Code](#): The OIE *Terrestrial Animal Health Code* (the *Terrestrial Code*) provides standards for the improvement of animal health and welfare, and veterinary public health worldwide, including recommendations for safe international trade in terrestrial animals and their products. Chapters specifically relevant to the diseases addressed in this document include:
 - [4.13. Disposal of dead animals](#)
 - [6.2. The role of the Veterinary Services in food safety systems](#)
 - [6.3. Control of biological hazards of animal health and public health importance through ante- and post-mortem meat inspection](#)
 - [6.4. The control of hazards of animal health and public health importance in animal feed](#)
 - [7.7. Stray dog population control](#)
 - [8.5. Infection with *Echinococcus granulosus*](#)
 - [8.6. Infection with *Echinococcus multilocularis*](#)
 - [8.17. Infection with *Trichinella* spp.](#)
 - [15.4. Infection with *Taenia solium*](#)
- [OIE Manual of Diagnostic Tests and Vaccines for Terrestrial Animals \(Terrestrial Manual\)](#): This aims to facilitate international trade in animals and animal products and to contribute to the improvement of animal health services world-wide. The principal target readership is laboratories conducting veterinary diagnostic tests and surveillance, plus vaccine manufacturers and regulatory authorities. The objective is to provide internationally agreed diagnostic laboratory methods and requirements for the production and control of vaccines and other biological products. Chapters specifically relevant to the diseases addressed in this document include:
 - [3.1.6. Echinococcosis](#)
 - [3.1.20. Trichinellosis](#)
 - [3.9.5. Cysticercosis](#)
- OIE Technical Disease Cards: [Fasciola gigantica \(Infection with\).pdf \(oie.int\)](#) and [Fascioloides magna \(Infection with\).pdf \(oie.int\)](#)
- [The OIE PPP Handbook: Guidelines for public-private partnerships in the veterinary domain](#). OIE 2019.
- **Codex Alimentarius**: The Codex Alimentarius, or “Food Code”, is a collection of standards, guidelines and codes of practice adopted by the Codex Alimentarius Commission. The Commission, also known as CAC, is the central part of the Joint FAO/WHO Food Standards Programme and was established by FAO and WHO to protect consumer health and promote fair practices in food trade.
 - [Code of hygienic practice for meat. CAC/RCP 58-2005](#)
 - [Guidelines for the control of *Trichinella* spp. in meat of suidae. CAC/GL 86-2015](#)
- [FAO/OIE/WHO Fact sheets on foodborne parasitic zoonoses](#)
- **FAO Food Safety – Technical Toolkit for Asia and the Pacific, 2021**:
 - No. 2. [Backyard farming and slaughtering – keeping tradition safe](#)
 - No. 7. [Parasites in food – an invisible threat](#)
- FAO/OIE. 2010. Good practices for biosecurity in the pig sector – Issues and options in developing and transition countries. FAO animal production and health paper 169.
<http://www.fao.org/3/i1435e/i1435e00.htm>
- Miller, Miknis and Flogry. 2020. Carcass management disposal – effective disposal of animal carcasses and contaminated materials on small to medium-sized farms. FAO Animal Production and Health Guidelines No. 23. Rome, FAO. <http://www.fao.org/3/cb2464en/CB2464EN.pdf>

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