Infections caused by Cestods - Part I

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Helminths –“ Worms“
2 major phyla
- Nematodes (roundworms)
  - Intestinal worms
    (soil transmitted worms)
  - Filarial worms
- Platyhelminths (flat worms)
  - Trematods (flukes)
  - Cestods (tapeworms)

35 animal phyla
- Nematodes: > 25,000 species
- Platyhelminths: appr. 25,000 species

Tapeworms consist of
- Scolex
  - Equipped with suckers, grooves (bothria) or hooks
  - Means of attachment to the intestinal wall
  - Actively growing neck region (strobila)
- Chain of segments (proglottids), variable in number
  - Mature towards end of chain
- Mature proglottids are largely composed of hermaphrodite sexual organs

Cestods – Structure of adults

Cestods – general aspects

- All cestodes are parasitic and their life histories vary
- Typically the adults live in the digestive tracts of vertebrates (definite host)
- And often as juveniles in the bodies of other species of animals (intermediate host)
- Over a thousand species have been described
- All vertebrate species may be parasitised by at least one species of tapeworm.

Diphyllobothrium latum
Fish tape worm
**Diphyllobothrium latum**

**Geographic Distribution**
- Northern Hemisphere (Europe, North America, and Asia) and in South America (Uruguay and Chile).
- Freshwater fish infected with *Diphyllobothrium* sp. larva may be transported to and consumed in geographic areas where active transmission does not occur.
- Cases of *D. latum* infection associated with consumption of imported fish have been reported in Brazil.

**Diphyllobothrium species**
- *D. latum*
- *D. pacificum*
- *D. cordatum*
- *D. ursi*
- *D. dendriticum*
- *D. lanceolatum*
- *D. dalliae*
- *D. yonagoensis*
- *D. nihonkaiense* = *D. klebanovskii*

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**Diphyllobothrium – life cycle**

1. **Immature eggs** are passed in feces.
2. **Eggs** mature (~ 18 to 20 days) and yield oncospheres which develop into coracidia.
3. Coracidia ingested by a suitable first intermediate host (freshwater crustacean, e.g. a copepod) → coracidia develops into procercoid larvae.

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**Diphyllobothrium latum**

**Clinical presentation**
- Can be a long-lasting infection (decades).
- Most infections are asymptomatic.
- **Manifestations may include**
  - abdominal discomfort
  - diarrhea, vomiting, and weight loss
  - Massive infections may result in intestinal obstruction
  - Migration of proglottids can cause cholecystitis or cholangitis
  - Vitamin B12 deficiency with pernicious anemia has been described in the past.
**Diphyllobothrium**

**Laboratory Diagnosis**
- Identification of eggs in the stool by microscopy
  - High sensitivity (95%) due to high no. of excreted eggs
  - Usually concentration techniques not required
- Identification of proglottids passed in the stool and staining can also be of diagnostic value

**Diphyllobothrium spp. eggs**

**Eggs of D. latum** in an iodine-stained wet mount
- Oval or ellipsoidal
- Range in size from 55 to 75 µm by 40 to 50 µm
- Operculum at one end

**Diphyllobothrium spp. eggs**

**Stool sample, unstained wet-mount**

**Diphyllobothrium Treatment**

**Praziquantel**
- Adults: 5-10 mg/kg orally in a single dose
- Children: dosage is the same as for adults
- Praziquantel should be taken with liquids during a meal

**Alternative: Niclosamide (Yomesan® 500mg Tbl.)**
- Adults: niclosamide 2 g orally once
- Children: 50 mg/kg (max. 2 g) orally once
- Niclosamide must be chewed thoroughly or crushed and swallowed with a small amount of water

**Cestods: Scolex and proglottids of tapeworms**

**Dipylidium caninum**
(double-pore tapeworm, flea tapeworm, cucumber tapeworm)
**Dipylidium caninum**

- Zoonotic tapeworm
- Ubiquitous tapeworm of dogs and cats
- Human infections have been reported in Europe, the Philippines, China, Japan, Argentina, and the United States.
- Fleas of dogs are intermediate host
- Humans can be infected accidentally by ingestion of infected dog fleas
  - Usually children
  - Uncommon infection
- Worms can develop to maturity in the human gut

**Clinical Presentation**

- Usually asymptomatic in humans
- Mild gastrointestinal disturbances may occur.
- Pets may exhibit behavior to relieve anal pruritis (such as scraping anal region across grass or carpeting)
- The infection is self-limiting in the human host and typically spontaneously clears by 6 weeks

**Diagnosis**

- Most striking feature in animals and children consists of the passage of proglottids
  - Proglottids have the size of rice grains
  - Found in the perianal region, in the feces, on diapers, and occasionally on floor covering and furniture
  - Shed usually intact in the stool
  - Hardly any eggs in the stool
  - Proglottids are motile when freshly passed and may be mistaken for maggots or fly larvae

**Eggs**

- Eggs are round to oval (average size 35 to 40 µm; range 31 to 50 µm by 27 to 48 µm)
- Contain an oncosphere that has 6 hooklets.
Dipylidium caninum treatment of humans

Praziquantel,
- Adults: 5-10 mg/kg orally in a single-dose therapy
- not approved for treatment of children < 4 years
- but has been used in children as young as 6 months

Niclosamide
- Effective, alternative
- Appearance of proglottids after therapy is indication for retreatment.
- The infection is self-limiting in the human host and typically spontaneously clears by 6 weeks.

Hymenolepis nana
The Dwarf Tapeworm

Hymenolepiasis

Hymenolepiasis is caused by two cestodes (tapeworm) species:
- *Hymenolepis nana* (the dwarf tapeworm)
  - probably the most common tapeworm in humans
  - also common in mice
- and *Hymenolepis diminuta* (rat tapeworm)
  - frequently found in rodents
  - infrequently seen in humans

Hymenolepis nana
Morphology

- Length: 2-4 cm, 100 -200 proglottids
- Scolex 0.3 mm, Rostellum with 20-30 hooklets

Hymenolepis diminuta
Morphology

- Length: 20-60 cm, 800 -1000 proglottids
- Scolex 0.2-0.4 mm, Rostellum without hooklets

Geographic Distribution

*Hymenolepis nana* is the most common cause of all cestode infections
- encountered worldwide
- estimated 75 million people infected
- In warm climates and under poor hygienic conditions prevalence in children 2-3%
- In temperate areas its incidence is higher in children and institutionalized groups.

*Hymenolepis diminuta* has been reported from various areas of the world. Less frequent.
Hymenolepiasis
Clinical presentation
- The adult worms live in the small intestine (ileum)
- *Hymenolepis nana* and *H. diminuta* infections are most often asymptomatic
- Heavy infections with *H. nana* may cause
  - Gastrointestinal discomfort
  - Abdominal pain
  - Poor appetite / anorexia
  - Diarrhea
  - Weakness
  - Headaches
- Complications (rare): dehydration from prolonged diarrhea

Hymenolepis nana
A cysticercoid is the larval stage of certain tapeworms. The cysticercoid larva contains the invaginated scolex of the parasite.

Hymenolepis spp.
Transmission
Humans and other animals can become infected in 2 ways:
- when they intentionally or unintentionally eat material containing embryonated eggs (e.g. food contaminated by insects)
- when they intentionally or unintentionally ingest arthropods containing the cysticercoid stage

Hymenolepis nana
Internal autoinfection cycle
*H. nana* is
- the only cestode that parasitizes humans without requiring an intermediate host
- the entire life cycle to be completed in the bowel
- infection can persist for years although lifespan of an adult is only 4-6 weeks
How does that happen?
- Eggs release their larva (oncosphere) already within the lumen of the bowel
- Oncosphere attaches to the mucosa and develops via cysticercoid stage to an adult worm

Hymenolepis nana
Internal autoinfection cycle
- No reports on *Hymenolepis* hyperinfection syndrome in patients with
  - HIV-Infection
  - Corticosteroid therapy
  (in comparison to *Strongyloides stercoralis*)
**Diagnostic Tests**

**Microscopy**
- Examination of the stool for eggs and parasites confirms the diagnosis
- Concentration techniques + repeated examinations recommended to detect light infections

**Serology**
- The cercocyst stage has contact with the host immune system → sufficiently predictable antibody response
- ELISA, sensitivity about 80%
**Hymenolepiasis**

**Treatment**

- **Praziquantel**
  - Adults and children: 25mg/kg in a single-dose therapy

- **Alternatives:** Niclosamide
  - Adults: 2 g in a single dose for 7 days
  - Children 11-34 kg: 1 g in a single dose on day 1 then 500 mg per day orally for 6 days
  - Children > 34 kg: 1.5 g in a single dose on day 1 then 1 g per day orally for 6 days

- **Nitazoxanide**
  - Adults, 500 mg orally twice daily for 3 days
  - Children aged 12-47 months: 100 mg orally twice daily for 3 days
  - Children 4-11 years: 200 mg orally twice daily for 3 days

**Prevention**

- **H. nana** infection is most common in areas where sanitation and handwashing are challenging
  - → Hand hygiene: washing their hands with soap and warm water
  - → Food hygiene: washing, peeling, or cooking all raw vegetables and fruits with safe water before eating

**Taeniasis**

**Geographic Distribution**

- **Taenia saginata** and **T. solium** are worldwide in distribution
- **Taenia solium** is more prevalent in poorer communities
  - humans living in close contact with pigs
  - eating undercooked pork
- **Taenia asiatica** is limited to Asia, described in Taiwan, South Korea, Indonesia, the Philippines, Thailand, south-central China, Vietnam, Japan and Nepal

**Clinical Presentation of intestinal infestation**

- **Taenia saginata** taeniasis produces only mild abdominal symptoms
  - most striking feature consists of the passage (active and passive) of proglottids
  - Occasionally, appendicitis or cholangitis can result from migrating proglottids

- **Taenia solium** taeniasis is less frequently symptomatic than **Taenia saginata** taeniasis
  - main symptom is often the passage (passive) of proglottids.
The most important feature of *Taenia solium* taeniasis is the risk of development of **cysticercosis**

**Taenia saginata / solium**

**Morphology**

*T. saginata*
- Length of adult worms is usually < 5 m (max. 25 m) with 1,000 to 2,000 proglottids
- Up to 100,000 eggs per proglottid

*T. solium*
- *Length of adults* 2 to 7 m with an average of 1,000 proglottids
- Up to 50,000 eggs per proglottid
- approximately 6 mature proglottids are passed in the stool per day

**Cestods: Scolex and proglottids of tapeworms**

**Taenia saginata**
- Proglottid of *T. saginata* injected with Indian Ink

**Scolex of Taenia solium**: globular in outline with four circular suckers. Rostellum armed with double row of alternating large and small hooklets (armed *scolex*)

**Scolex of Taenia saginata**: quadrate in outline, four circular suckers. Rostellum and hooklets are absent (unarmed *scolex*)

**Diphyllobothrium latum** - fish tapeworm
Adult *Taenia saginata* tapeworm
- The adult is attached to, and residing in the small intestine.

The proglottids of *Taenia* species can be identified by the number of uterine branches; 7-13 for *T. solium* and 15-20 for *T. saginata*.

### Taenia spec. - Morphology of eggs

Taenia sp. egg in unstained wet mounts: 30-35 µm in diameter and are **bile stained**. The internal oncosphere contains six refractile hooks. Eggs of *Taenia solium* and *Taenia saginata* are morphologically indistinguishable.

### Epidemiology of Taenia asiatica

First described about 50 years ago
- Based on the paradoxical observation of high prevalences of *T. saginata*-like tapeworms in non-beef consuming populations
- Life cycle of *T. asiatica* is comparable to that of *T. saginata*.
  - Except for pigs being the preferential intermediate host
  - Liver the preferential location of the cysts
- Whether or not *T. asiatica* can cause human cysticercosis, as is the case for *Taenia solium*, remains unclear

### Taenia asiatica
- Transmission requires in particular the consumption of raw or poorly cooked pig liver
- Transmission of *T. asiatica* shows an important ethno-geographical association!
- Molecular tools indicated that *T. asiatica* is related more closely to *T. saginata* than to *T. solium*
**Taeniasis - Diagnosis**

- Microscopic identification of eggs and proglottids in feces is diagnostic for taeniasis,
  - not possible during the first 3 months following infection, prior to development of adult tapeworms (prepatent period)
- Eggs of *Taenia* spp. are indistinguishable
- Microscopic identification of gravid proglottids (or, more rarely, examination of the scolex) allows species determination

*Take extreme care in processing unpreserved specimen. Ingestion of eggs can result in cysticercosis!*

**Intestinal Taeniasis**

**Treatment**

**Praziquantel**
- 5-10 mg/kg orally once for adults and for children.
- If the patient has cysticercosis in addition to taeniasis, praziquantel should be used with caution
- Praziquantel is cysticidal and can cause inflammation around dying cysts in those with cysticercosis, which may lead to seizures or other symptoms

**Cysticercosis**

*A disease caused by the larval stage of *Taenia solium*

**Taeniasis - Diagnosis**

**Serology**

- Intestinal taeniasis does not result in significant antibody response
- Useful only in case of cysticercosis

**Intestinal Taeniasis**

**Treatment**

**Alternative: Niclosamide**
- Adults: 2 g orally once
- Children 50 mg/kg orally once
- After treatment, stools should be collected for 3 days to search for tapeworm proglottids for species identification
- Stools should be re-examined for *Taenia* eggs 1 and 3 months after treatment to proof cure
Cysticercosis

**Geographical Distribution**
- *Taenia solium* is found worldwide
- Pigs are intermediate hosts of the parasite
  - Therefore completion of the life cycle occurs in regions where humans live in close contact with pigs and eat undercooked pork
- Taeniasis and cysticercosis are very rare in Muslim countries

**Clinical Presentation**
- Symptoms are caused by the development of cysticerci in various sites
- Of greatest concern is cerebral cysticercosis (or neurocysticercosis) with diverse manifestations:
  - Seizures
  - Mental disturbances
  - Focal neurologic deficits
  - Signs of space-occupying intracerebral lesion
  - Death can occur suddenly

**Epilepsy and Neurocysticercosis (NCC)**

**Systematic Review of Studies from LA, SSA, Asien** (Ndimubanzi, PLOSNTDs, Nov. 2010)
- Data on the prevalence within the entire population inconsistent
- Data on NCC in patients with epilepsy showed better consistency
- Estimated prevalence from pooled data: 29.0% (95% CI: 22.9%–35.5%) of acquired epilepsy is caused by NCC

**Epidemiology of neurocysticercosis**
- Extracerebral cysticercosis may present with:
  - Ocular lesions
  - Cardiac
  - Or spinal lesions with associated symptoms
  - Subcutaneous nodules and calcified intramuscular nodules are common, usually asymptomatic
Prevalence of cysticercosis

- In Latin America estimated 400,000 people have symptomatic disease

Seroprevalence-Studies

- Mexico: between 3.1 and 3.9 %
- in areas of Guatemala, Bolivia, and Peru as high as 20 % in humans and 37% percent in pigs
- In Ethiopia, Kenya and the DR of Congo around 10% of the population seropositive
- Madagascar 16%

Cysticercosis

Diagnosis

- Imaging techniques
- Histopathology
- Serological diagnosis]
  - ELISA
  - Immunoblot
  - Individuals with intracranial lesions and calcifications may be seronegative
  - Usually not available in resource limited settings

Neurocysticercosis

Therapeutic options

Decision to treat is complex and depending on

- Clinical presentation
- Stage of the cysts (vital – degenerated - calcified)
- Number and location of cysts

Neurocysticercosis - Guidelines

Evidence-based guideline: Treatment of parenchymal neurocysticercosis

Neurology 80 April 9, 2013

- Albendazol +/- Corticosteroids effective and well tolerated
- Significant reduction in frequency of seizures
- Reduction in number and size of cysts in imaging techniques

Racemose cysticercosis

- In subarachnoid space and fissures the cysticercus may develop into a large (~20cm), lobulated lesion called racemose cysticercosis
- Special form, rare
- Does not build scolices
- Cysts located within the ventricles of the brain can block the outflow of CSF and cause symptoms of increased intracranial pressure
Cysticercosis is considered as “tools-ready disease” according to WHO. No animal reservoirs besides humans and pigs. The only source of *Taenia solium* infection for pigs are humans, the definite host. Theoretically, breaking the life cycle seems feasible.

### Prevention

**Possible strategies**
- Chemotherapy of infected individuals
- Improving sanitation and education
- Cooking of pork or freezing it
- Meat inspection
- The separation of pigs from human faeces by confining them in enclosed piggeries
- In Western European countries post pigs are housed - main reason for pig cysticercosis largely being eliminated

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**Echinococcosis**

- Zoonosis
- Infection occurs by oral ingestion of Echinococcus eggs
- Echinococcus eggs are excreted in the stool of infected foxes, dogs or cats
- Infection may occur by direct contact with infected animals or by ingestion of contaminated food
- Humans are an accidental intermediate host for the larval stage of the parasite
- The therapy of larval stage cestod infections continues to be a problem!

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**Echinococcus – Live cycle**

Prepatent period: *E. granulosus* 48-60 d
*E. multilocularis* 35-45 d
Echinococcus multilocularis

Echinococcus granulosus egg in faeces

Gross pathology of cotton rat infected with Echinococcus multilocularis. First E. multilocularis isolated in the United States. CDC.

Echinococcosis

2 different clinical entities:
- Cystic echinococcosis
  - Echinococcus granulosus
  - E. cysticus, Hydatidosis
  - Dog tapeworm
- Alveolar Echinococcosis
  - Fox tapeworm
  - Echinococcus multilocularis

Echinococcosis

Rare
- Polycystic Echinococcosis
  (Neotropical Echinococcosis)
- caused by Echinococcus vogeli
  or very rarely by Echinococcus oligarthrus

Distribution of Echinococcus granulosus and cystic echinococcosis (hydatidosis), 2009

Rates of confirmed echinococcosis cases reported in the EU/EEA, by age and gender, 2011

![Graph showing rates of confirmed cases of echinococcosis by age and gender in 2011.]

Source: Country reports from Austria, Belgium, Bulgaria, Cyprus, Finland, France, Germany, Greece, Hungary, Latvia, Lithuania, Luxembourg, Norway, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.

ECDC, Annual epidemiological report 2013

Trend and number of confirmed cases of echinococcosis reported in the EU/EEA, 2007–2011

![Graph showing trend and number of confirmed cases of echinococcosis reported in the EU/EEA, 2007–2011.]

Source: Country reports from Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Latvia, Lithuania, Malta, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden and the United Kingdom.

ECDC, Annual epidemiological report 2013

Echinococcosis cases in Germany / Europe

<table>
<thead>
<tr>
<th>Year</th>
<th>Germany</th>
<th>Europe</th>
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<tr>
<td>2007</td>
<td>89</td>
<td>966</td>
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<td>2008</td>
<td>102</td>
<td>911</td>
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<tr>
<td>2009</td>
<td>106</td>
<td>775</td>
</tr>
<tr>
<td>2010</td>
<td>117</td>
<td>738</td>
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<tr>
<td>2011</td>
<td>142</td>
<td>783</td>
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- Bulgaria and Germany are the countries with the highest number of reported cases in Europe
- Bulgaria had 307 confirmed cases in 2011

ECDC, Annual epidemiological report 2013

Diagnosis of Echinococcosis

- Imaging techniques
  - Ultrasound
  - CT
  - MRT
  - FDG-PET-CT
- Serology
  - Measuring serum antibodies against Echinococcus multilocularis or Echinococcus granulosus
- Microscopy / Histology
  - Biopsies, Aspiration
- PCR for Echinococcus-DNA
- Differentiation of species possible

Diagnosis of Echinococcosis: Imaging techniques

<table>
<thead>
<tr>
<th>CE1</th>
<th>CE2</th>
<th>CE3a</th>
<th>CE3b</th>
<th>CE4</th>
<th>CE5</th>
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<td>MRI</td>
<td>CT</td>
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CE1: unilocular simple cyst with liquid content and often with the CE1-specific "double line sign"
CE2: multilocular, multiseptated cysts
CE3a: cysts with liquid content and the CE3a-specific detached endocyst
CE3b: unilocular cysts with daughter cysts inside a mucinous or solid cyst matrix
CE4: heterogeneous solid cysts with degenerative, CE4-specific cannoncircular structure of the cyst content
CE5: cysts with degenerative content and heavily calcified wall.

Approximate geographical distribution of Echinococcus multilocularis and alveolar echinococcosis (1999)

[Map showing the approximate geographical distribution of Echinococcus multilocularis and alveolar echinococcosis (1999).]
Diagnosis of Echinococcosis: Imaging techniques
- Ultrasound is the most important imaging technique for diagnosis, staging and follow-up
- MRI reproduces the details visible in sonography better than CT-scan
- In case sonography is not possible MRI with a T2-weighed series should be preferred to CT
- FDG-PET-CT might be useful prior to operation or for follow-up in cases of E. multilocularis

Diagnosis of Echinococcosis: Serology
- Specific antigens available
- Available tests usually not standardised
- Specificity and sensitivity frequently not known
- Sensitivity of serological tests is depending on different factors like location, size, stage of cysts
- Early cyst stages (C1) and the stage of involution (C5) frequently seronegative

Diagnosis of Echinococcosis: Serology
- Screenning test usually haemagglutination test
- Fluid from a E. granulosus hydatid is used as raw antigen.
- Sensitivity ca. 80% for CE, ca. 94-97% for AE
- Confirmation test for AE with purified / recombinant antigens
- Em2plus-ELISA
- Sensitivity 90-100%
- Specificity 95-100%

Therapy of Echinococcosis
- Echinococcus granulosus (cysticus)
  - Surgery
  - Pair (Puncture, Aspiration, Injection of a scolecidal agent and Reaspiration)
  - Chemotherapy: Albendazol
  - „Wait and Watch“ - Strategy
- Echinococcus multilocularis (alveolaris)
  - Surgery
  - Chemotherapy: Albendazol, liposomal Amphotericin B
  - Liver transplantation

Echinococcosis – When to consider?
- Cystic liver lesion, especially in patients coming from endemic areas, e.g. migrants
  - Stage CE1 difficult to differentiate from dysontogentic liver cysts
  - Serology frequently negative in case of small cysts
  - Follow up by ultrasound + serology
- Obscure hypoechoic / inhomogenous lesion in the liver with undefined margins: suspicious of an infiltrating malignant tumor
  - History: dog owner, Hunter
**Echinococcosis Prevention**
- Do not feed dogs with raw offal from slaughtered animals
- Regular deworming of dogs / cats
  - Minimum every 3 months
- Careful handling of animals with high rate of echinococcus infections, e.g. foxes

**Prevention of cystic echinococcosis**
Cystic echinococcosis is controlled by preventing transmission of the parasite
- Prevent dogs from feeding on the carcasses of potentially infected animals, esp. sheep, do not feed them on raw offal!
- Regular deworming of dogs
- Control of stray dog populations
- Restrict home slaughter of sheep and other livestock.
- Wash your hands with soap and warm water after handling dogs, and before handling food.

**Prevention of alveolar echinococcosis**
Alveolar echinococcosis can be prevented by avoiding contact with wild animals such as foxes, coyotes, and dogs and their fecal matter
- Do not allow dogs to feed on rodents and other wild animals
- Regular deworming!
- Avoid contact with wild animals such as foxes, coyotes and stray dogs
- Do not encourage wild animals to come close to your home or keep them as pets
- Wash your hands with soap and warm water

**Coenurosis**
*Taenia multiceps and Taenia serialis*
- Coenurosis is infection by the metacestode larval stage (coenurus) of *Taenia multiceps* and *T. serialis*.
- Coenurosis is a zoonosis
- Coenuri of *T. multiceps* are usually found in the eyes and brain; those of *T. serialis* are usually found in subcutaneous tissue.

**Geographic Distribution**
- Widespread, most of the cases are from Africa
- Few cases reported from sheep-raising areas of Europe, South America, the United States and Canada.
- Many *canids* can serve as definitive hosts for *T. multiceps*.
- Only *dogs and foxes* can serve as definitive hosts for *T. serialis*.
- Many animals may serve as intermediate hosts.
**Coenurosis**

**Colloquial term „gid” or „sturdy”**

Parasitic disease primarily of sheep causing neurological sequelae.

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**Life cycle**

*Taenia multiceps*  
*Taenia serialis*

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**Coenurosis**

**Clinical Presentation**

- Coenuri in the skin or subcutaneous tissue usually present as painless nodules. The lesions are often fluctuant and tender.
- Most subcutaneous nodules manifest on the trunk, sclera, subconjuctiva, neck, shoulders, head and limbs.
- Clinically, coenuri may mimic lymphomas, lipomas, pseudotumors, or neurofibromas.
- Coenuri in the central nervous system may cause headache, fever and vomiting.

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Coenuri in the eye cause both intraocular and orbital infections.

- Patients may present with varying degrees of visual impairment.
- If not removed, coenuri in the eye may cause pain.

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Cross-section of a human eye, showing multiple protoscoleces within a coenurus.

Corresponding histology: protoscoleces.
**Laboratory Diagnosis**
- Diagnosis is made by the observation of coenuri in biopsy or autopsy specimens.
- Coenuri are usually readily distinguished from cysticerci by the presence of multiple protoscolices.

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**Coenurosis Treatment**
- Usual treatment for intracranial coenurosis is surgical excision.
- Eye surgery is an option for ocular coenurosis, recovery of vision has been reported.
- Coenuri are susceptible to praziquantel, but
- In intraocular coenurosis praziquantel may cause death of the parasite followed by a severe inflammatory reaction resulting in

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**Taenia crassiceps**

- *Taenia crassiceps* is tapeworm of foxes and coyotes (prairie wolf) (definitive host), less frequently found in dogs and rarely in cats.
- Intermediate hosts are rodents.
- The larval stage (cysticercus longicollis) multiplies within internal organs of the intermediate host by asexual budding.

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**Taenia crassiceps human cases**
- Very rarely found in humans.
- Infection of humans is thought to occur after consumption of food or water contaminated with infective ova shed in carnivore feces.
- Nearly all recognized cases involving the muscles or subcutis of humans have been associated with underlying immunosuppression.
- In contrast, intraocular infections do not

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**Taenia crassiceps**

- **Geographic distribution**
  - Northern Hemisphere
  - North America, Europe, and Russia
  - Prevalence among foxes in Germany (24%) and Lithuania (26.4%) is high, in Denmark (0.2%) low.

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**Cerebellar Cysticercosis Caused by Larval Taenia crassiceps Tapeworm in Immunocompetent Woman, Germany**

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Emerging Infectious Diseases • www.cdc.gov/eid • Vol. 19, No. 12, December 2013
Cerebellar Cysticercosis Caused by Larval *Taenia crassiceps* Tapeworm in Immunocompetent Woman, Germany

**A** Section through parasite body showing multiple connected bladders (asexual budings) at the caudal end.

**B** Transverse section through the parasite’s protoscoleces showing numerous hooklets, similar to *T. solium* tapeworm larvae.

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The source of infection for the patient remained unclear. Her dog was probably the major risk factor allowed to roam freely in the nearby forest. Did not have regular deworming. Preventive measure: carnivorous pets should undergo regular deworming!

Serologic test results for echinococcosis were negative.

- crude and recombinant antigen
- ELISAs and indirect hemagglutination test results were negative (11)

Commercial Western blots for cysticercosis and echinococcosis showed weak atypical bands of 47 kDa and 30 kDa, respectively.

The patient underwent neurosurgery. Histology revealed structures typical for cestode larval infection. Final diagnosis was made by cestode-specific PCRs selective for the parasite’s mitochondrial 12S rRNA gene and mitochondrial cytochrome c oxidase subunit I gene. After sequencing and comparison with genom-databases sequences showed 99% and 100% homology with the *T. crassiceps* tapeworm.

After surgery, the patient was given praziquantel (600mg bid) and albendazole (400 mg bid) for 3 months.

Postoperative course was uneventful. The patient recovered rapidly. No clinical or radiographic signs of recurrence after a followup period of 18 months.