



International Journal of Veterinary Sciences and Animal Husbandry



ISSN: 2456-2912

NAAS Rating (2025): 4.61

VET 2025; 10(12): 598-602

© 2025 VET

www.veterinarypaper.com

Received: 22-10-2025

Accepted: 26-11-2025

David Karunyakaran H

Ph.D. Scholar, Department of
Veterinary Clinical Medicine,
Madras Veterinary College,
Tamil Nadu Veterinary and
Animal Sciences University,
Chennai, Tamil Nadu, India

Neurocysticercosis: In's and out's

David Karunyakaran H

DOI: <https://www.doi.org/10.22271/veterinary.2025.v10.i12i.2898>

Abstract

Neurocysticercosis (NCC) is a major zoonotic parasitic disease of veterinary and public health importance, caused by the larval stages of *Taenia solium*, with pigs acting as the principal intermediate hosts and humans as both definitive and accidental intermediate hosts. In endemic regions with traditional pig production, NCC is the leading cause of acquired epilepsy in humans and is tightly linked to free-roaming pig husbandry, inadequate sanitation, and access of pigs to human feces. NCC arises when *T. solium* eggs shed in the feces of human tapeworm carriers are ingested by pigs or humans, leading to systemic cysticercosis, including neurocysticercosis when cysts localize in the central nervous system. In India and other endemic areas of Asia, Latin America, and sub-Saharan Africa, porcine cysticercosis is highly prevalent and sustains transmission in poor, rural pig-farming communities. The disease burden in people is considerable, with NCC recognized as a neglected tropical disease and a major cause of epilepsy and disability in low-resource settings.

From a veterinary perspective, control in pigs is pivotal and includes confinement, preventing access to human feces, strategic anthelmintic treatment with oxfendazole, meat inspection, and vaccination with the recombinant TSOL18 (Cysvax) vaccine, which has shown high efficacy in field trials. Integration of pig-focused interventions with human-focused measures—sanitation, treatment of human tapeworm carriers, and food safety—under a One Health framework is central to the WHO neglected tropical disease road map 2021-2030 targeting taeniasis-cysticercosis for intensified control.

Keywords: Neurocysticercosis, taeniasis, central nervous system

Introduction

Definition

Neurocysticercosis is defined as a parasitic infection of the Central Nervous System, due to the larval stages of the parasite *Taenia solium* (pork tapeworm).

Neurocysticercosis is a leading cause of acquired epilepsy in endemic areas. The disease involves of multiple tissues. It is not to be confused with Taeniasis (disease caused due to infestation of adult tapeworms in the intestine).

Importance as a zoonotic disease

It is the most common parasitic infection of the human central nervous system. It is a major public health issue in low-income countries. The disease is increasingly found in developed nations due to migration and travel. Humans mainly get the infection by eating undercooked pork.

History

Ancient texts during the Greek and Roman Era describe round cysts like lesions as BLADDERS in pigs and cattle. In the year 424 B.C., Aristotle described the presence of multiple cysts in porcine diseases. During the middle ages, the terms “Measly pork/Pearly pork” were used. During the 17th Century, cysts in the human brain were discovered on autopsies. During the 1850s, Johann Georg von Siebold, for the first time, described the full life cycle of *Taenia solium*. He also discovered that humans act as both definitive and intermediate hosts, and also noted that the infection is also by cysts, not just the adult tapeworm. In the 20th Century, Subcutaneous nodules were found associated with *Taenia*

Corresponding Author:

David Karunyakaran H

Ph.D. Scholar, Department of
Veterinary Clinical Medicine,
Madras Veterinary College,
Tamil Nadu Veterinary and
Animal Sciences University,
Chennai, Tamil Nadu, India

solium infection. During the 1910s - 1930s, in Europe and Latin America, Scientists confirmed the presence of the larvae of *Taenia solium* in the Central Nervous System. In the 1970s, the Computed Tomography technique, and in the 1980s, the Magnetic Resonance Imaging technique helped in better diagnosis of this disease by means of non - invasive visualization of the cysts and scolices in the brain. In the 1990s, this disease was found to be a leading cause of acquired epilepsy in human beings. In the 2000s, epidemiological studies were undertaken in developing countries, and the concept of vaccination and one health approach strategies came into existence.

Causative agent

The causative agent of Neurocysticercosis is *Taenia solium* (pork tapeworm). It belongs to the class Cestodae, and family Taeniidae. The two stages that are present, are the adult (intestinal) and larval (*Cysticercus cellulosae*) stages. Humans act as both definitive and as accidental intermediate hosts.

Hosts

Humans are the definitive hosts for the infection. They harbour the parasite and the infection by consuming undercooked pork. The common intermediate host is the pig; however, certain studies say that in Asia, dogs also act as intermediate host. Humans also act as Accidental intermediate hosts, developing Neurocysticercosis after ingesting eggs. There are no vectors involved.

Transmission

The main mode of transmission is the faeco - oral ingestion of *Taenia solium* eggs. Autoinfection in tapeworm carriers is also possible. This is a zoonotic cycle involving pigs and humans.

Global Epidemiology

This disease is considered as a neglected tropical disease. Around 2.5 to 8.3 million people are infected annually, according to WHO report 2016. WHO recognised this disease in the year 2010. This disease is endemic in Latin America, Asia, and Africa. In Asia, India, China and Nepal are most commonly affected. Neurocysticercosis seems to be a leading cause of epilepsy in developing countries. The risk factors contributing to the global epidemiology of the disease or lack of sanitation, presence of free roaming pigs, poor meat inspection, inadequate cooking and close human pig contact. These risk factors contribute to the transmission of the disease by means of open defecation, which leads to environmental contamination with eggs, injection of human faeces with larvae, by pigs, entry of infected pork into the human food chain, survivability of viable cysticerci in the pork post improper cooking, and high risk in pig keeping communities. Porcine cysticercosis accounts for 20 - 30% of the disease in rural endemic areas (India, Africa and Latin America). 1 - 3% of the human population may carry tapeworms, and act as source of infection. Young adults (15 - 45 years) are more commonly affected. Males seem to be more commonly affected due to the occupational hazard.

Epidemiology In India

The prevalence of the disease is 4 - 12% in rural/peri - urban areas. The exposure rates are 10 - 30% in endemic zones. Pig farming, free roaming pigs and poor sanitation increases risk. Inability of clean water supply is also an important factor in endemic nations. Neurocysticercosis accounts for around 25 -

30% of all epilepsy cases in India. It is a major cause of seizures in southern and eastern India. (upto 51% of new cases are reported). In India most of the cases recorded are a single, isolated, parenchymal cysticercus, whereas in other endemic countries, like Latin America and Africa, multiple cysts and also in non - parenchymal areas are also recorded. In paediatric patients, 10 - 25% of the new - onset seizures are due to neurocysticercosis.

In South India, the risk of this disease is due to its high prevalence in rural population with pig farming. In North India, the risk is due to poor sanitation and high pig density. In North - East India, the low meat regulations serve as an important factor contributing to the risk of the disease. In West India, informal pig farming in rural areas are serving as risk factors. In East India, the presence of free roaming pigs and open defaecation serve as important risk factors. There are studies all over India over the past 30 years showing a varied percentages in the prevalence of neurocysticercosis as a cause of epilepsy in rural areas, paediatrics and seizure patients. Over the past decade, there are studies demonstrating the detection of Anti - cysticercal IgG antibodies positivity against Neurocysticercosis. In the year 2024, NCC has also been reported among HIV positive individuals.

Emerging disease perspective

Global transmission and travel spread the infection to non - endemic high-income regions. Urbanization and poor sanitation contribute to the emergence of the disease.

Public Health Burden

Neurocysticercosis contributes to around 2.8 million DALYs annually (Disability Adjusted Life Years). This disease produces a lot of economic loss and health care burden in endemic areas.

Lifecycle

The life cycle of Neurocysticercosis includes humans and pigs. Humans get the adult worm from undercooked pork and Neurocysticercosis from ingesting eggs. Pigs and dogs ingest eggs from human faeces and develop larval cysts. One adult worm can produce upto 1 lakh eggs per day. Humans get neurocysticercosis mainly autoinfection.

In the intestinal tract of the host, eggs get uncoated, liberating the enclosed larvae, called as oncospheres. The oncospheres penetrate the intestinal wall and enter the blood stream. From the bloodstream, the oncospheres enter the brain, eyes, skin and muscles, where they get deposited. This disease is called as cysticercosis. Inside the tissues, oncospheres develop into metacestodes, called cysticerci.

There are four stages of cysticerci in the tissues. Stage 1 is called as vesicular/viable stage. It has a membrane with fluid which has scolex. It can last from months to years. Stage 2 is called as colloidal stage, where turbid fluid is formed, and scolex undergoes degeneration. Stage 3 is called as granular nodule. Stage 4 is called as calcified nodule, which is non - viable.

Humans eat undercooked pork with viable cysticerci. In the small intestine, the digestive enzymes digest the vesicular membrane, and so the scolex starts to evaginate and attach to the wall of the intestine with the help of powerful suckers. The tapeworm matures into the adult form and gravid segments, called proglottids are released in the faeces to the environment. This stage is called Taeniasis, and it is not to be confused with cysticercosis.

Pathogenesis

The ingestion of eggs lead to the penetration of larva into the intestines, reaching the central nervous system through the blood stream, forming cysts. The host immune system is triggered upon cyst degeneration. There are chance of hydrocephalus, due to increased intracranial pressure when the cysts enter the cerebrospinal fluid. When there are numerous cysts in the brain, diffuse cerebral edema occurs.

Clinical Signs

The clinical signs in humans suffering from neurocysticercosis depend on cyst location, number and stage. Seizures and headache are the most common signs reported. Neuropsychiatric symptoms are also recorded. There is intracranial hypertension and cognitive deficits, visual loss and meningitis like symptoms as well. During severe systemic signs, immune responses can also occur, and these responses are activated by anti - helminthic drug treatment.

Forms of Neurocysticercosis

There are two main forms of neurocysticercosis

• Parenchymal neurocysticercosis

This form is more common, and has a better prognosis. There is accumulation of metacestodes in the small terminal blood vessels. There are acute symptomatic seizures in this form, along with headaches.

• Extraparenchymal neurocysticercosis

This form is relatively rare. The prognosis is poor in this form. The cysts enter the cerebrospinal fluid and reach the intraventricular, sub - arachnoid space and the associated meninges. Due to increased intracranial pressure, there will be hydrocephalus and edema. Sometimes the cysts will obstruct the CSF flow. If the cyst is a proliferating cyst cluster, it will lead to the formation of “Racemose cyst” which leads to vesicle aggregation.

• Spinal neurocysticercosis

It is a very rare form of neurocysticercosis and is recorded only in less than 0.01% of the affected population.

Immunomodulation in cysticercosis

Some individual molecules secreted by *Taenia solium* have been shown to have immunomodulating effects and aid as immune evasion mechanisms by the parasite. Proteases produced by cysticerci can degrade immunoglobulins and interfere with lymphocyte proliferation and cytokine production. Taeniastatin, a protease inhibitor secreted by cysticerci, inhibits lymphocyte activation and blocks IL - 2 and IL - 1 activation. Taeniastatin binds to C5a of the complement pathway and inhibits neutrophil chemotaxis and aggregation. Paramyosin, which is released by cysticerci, blocks complement - mediated immune responses by binding to and inhibiting the C1q component of the complement.

Diagnosis

Diagnosis of this condition is relatively difficult. Neuroimaging is key in the diagnosis of this condition. Serological tests support the diagnosis of this condition. Clinical history and epidemiology are important in supporting a diagnosis.

Imaging techniques

Computed Tomography shows calcified cysts and scolices. Magnetic resonance imaging is preferred for ventricular / sub

- arachnoid cysts. Characteristic “hole with dot” sign / “starry sky” appearance can be visualised, especially if multiple small cysts are present. Imaging techniques help visualize the cysticerci size, number and location. Viable cysticerci appear small, round and the scolex appears as a high density nodule. Degenerating cysts are always accompanied by perilesional edema.

Serological diagnosis

Enzyme linked immunotransfer blot, using lentil lectin purified glycoprotein, can detect antibodies. It has 100% specificity and 98% sensitivity. Enzyme linked immunosorbent assay is common, but less specific. It can detect *Taenia solium* antigens using monoclonal antibodies from *Taenia saginata*. Lateral flow assay can be done to detect extraparenchymal neurocysticercosis by means of detecting mAb HP 10. CSF analysis can be done in some cases.

Stool Microscopy

Stool microscopy is performed for the detection of *Taenia solium* egg. It is not confirmatory for active infection. It can be helpful in the detection of tapeworm carriers. It is a highly specific test with low sensitivity.

Table 1: Del Brutto Criteria for Neurocysticercosis:

Del Brutto Diagnostic Criteria for Neurocysticercosis		
Category	Criteria	
ABSOLUTE	- Histologic demonstration of parasite from CNS tissue - Cyst with scolex on Neuroimaging - Subretinal parasite seen on fundus exam	
MAJOR	- Neuroimaging highly suggestive (e.g. Ring - enhancing lesions, scolex) - Positive serum EITB for <i>T.solium</i> antibodies - Resolution of cysts after therapy - Spontaneous resolution of single enhancing lesion	
MINOR	- Imaging findings compatible but not specific - Clinical manifestations (e.g. seizures, focal deficits) - CSF abnormalities suggestive of NCC - Response to empirical antiparasitic therapy	
EPIDEMIOLOGIC	- Recent travel to endemic area - Household contact with <i>T.solium</i> carrier - Evidence of infection in local pigs or humans	
Diagnostic certainty	Definitive	1 Absolute OR 2 Major + 1 Minor + 1 Epidemiologic
	Probable	1 Major + 2 Minor 1 Major + 1 Minor + 1 Epidemiologic

Carpio diagnostic criteria for neurocysticercosis:

Parenchymal neurocysticercosis

Definitive parenchymal neurocysticercosis, one of the following:

- Parenchymal cyst with pathological diagnosis
- Single or multiple active parenchymal cysts, with at least one cyst with scolex on CT or MRI
- Multiple parenchymal vesicles without scolex associated with at least one of the following:
 - Seizures: focal or generalized tonic-clonic
 - Positive serum or CSF immunological test (ELISA, EITB)

4. Any combination of the parenchymal cysticercus in different evolutive stages: vesicular with or without scolex, degenerative (colloidal or nodular), and calcified

Probable parenchymal neurocysticercosis, one of the following

1. Single parenchymal calcification or vesicle (without scolex) or degenerating cyst(s), establishing differential diagnoses with other etiologies, associated with at least two of the following:
 1. Seizures: focal or generalized tonic-clonic
 2. Subcutaneous or muscle cysts location confirmed by biopsy
 3. Positive serum or CSF immunological test (ELISA, EITB)
 4. Plain X-ray films showing “cigar-shaped” calcifications
 5. Individual who lives or has lived in or has traveled frequently to endemic countries
2. Multiple parenchymal calcifications in an individual who lives or has lived in or has traveled frequently to endemic countries and in whom clinical state excludes other etiologies of calcifications

Parenchymal neurocysticercosis

Definitive parenchymal neurocysticercosis, one of the following:

1. Parenchymal cyst with pathological diagnosis
2. Single or multiple active parenchymal cysts, with at least one cyst with scolex on CT or MRI
3. Multiple parenchymal vesicles without scolex associated with at least one of the following:
 - a. Seizures: focal or generalized tonic-clonic
 - b. Positive serum or CSF immunological test (ELISA, EITB)
4. Any combination of the parenchymal cysticercus in different evolutive stages: vesicular with or without scolex, degenerative (colloidal or nodular), and calcified

Probable parenchymal neurocysticercosis, one of the following:

1. Single parenchymal calcification or vesicle (without scolex) or degenerating cyst(s), establishing differential diagnoses with other etiologies, associated with at least two of the following:
 - a. Seizures: focal or generalized tonic-clonic
 - b. Subcutaneous or muscle cysts location confirmed by biopsy
 - c. Positive serum or CSF immunological test (ELISA, EITB)
 - d. Plain X-ray films showing “cigar-shaped” calcifications
 - e. Individual who lives or has lived in or has traveled frequently to endemic countries
2. Multiple parenchymal calcifications in an individual who lives or has lived in or has traveled frequently to endemic countries and in whom clinical state excludes other etiologies of calcifications

Differential Diagnosis

Neurocysticercosis can be differentially diagnosed from other conditions that cause cysts/masses/granulomas in the brain

- Tuberculomas
- Abscesses
- Toxoplasmosis
- Gliomas

- Metastatic tumours
- Other epilepsy causes

Treatment

Goals

The main goals of treatment of neurocysticercosis is to eliminate the viable cysts, control inflammation and seizures, and manage complications like hydrocephalus.

Antiparasitic treatment

Antiparasitic therapy is indicated only during vesicular and colloidal stages. Albendazole, given at a dose rate of 15 mg/kg/day for 7 - 28 days, is the drug of choice for the treatment of neurocysticercosis. Albendazole is an imidazole derivative that impairs glucose uptake and metabolism in the parasite. Praziquantel is an isoquinoline that disrupts calcium homeostasis and produces paralysis in the parasite. Sometimes, combinations of these two drugs can be used in select cases. One major adverse effect of antiparasiticidal therapy is the mass death of cysts, which excites an extensive inflammatory response with perilesional edema.

Adjunctive therapy

Corticosteroids, (e.g. dexamethasone and prednisolone) can be administered either orally or parenterally to avoid excessive inflammations. Anti-epileptic drugs (e.g. Phenobarbital, Diazepam) can be administered to control seizures. Surgery can also be a useful option for hydrocephalus or obstructive cysts.

Prognosis

Parenchymal neurocysticercosis generally has a good prognosis, whereas extraparenchymal neurocysticercosis has a poor prognosis due to the spread of cysts. In a retrospective study conducted from 1985 to 2011, there were 1570 deaths due to extraparenchymal neurocysticercosis in the United Kingdom, and 221 deaths due to extraparenchymal neurocysticercosis in the United States of America.

Prevention and Control

Proper sanitation, meat inspection, proper cooking of pork, proper hand hygiene and treatment of tapeworm carriers are essential in the prevention and control of Neurocysticercosis. Pig - focused control measures include deworming with oxfendazole, preventing pigs from accessing human faeces, vaccination and meat inspection, mainly by lingual palpation. There is a vaccine, called SP3VAC vaccine, which is an anticysticercosis vaccine, which was in use until 2008, but later discontinued due to the vaccine related side effects encountered. TSOL - 18 Vaccine, which contains *Taenia solium* oncosphere antigen, is the only commercial vaccine available for pigs against neurocysticercosis in India. It is a recombinant vaccine antigen, and has a good scope for future research. Human-focused control measures include proper community education, mass deworming, and identification of tapeworm carriers.

Emerging and New Strategies

- Portable fluorescence sensors can be used for antibody detection, and the results can be captured on a mobile device.
- RT - PCR can be performed using the repetitive Tsol13 sequence.
- For drugs like triclabendazole, oxfendazole, pyrantel and albendazole, nanometer sized capsules are available,

using nanoparticles, which promote absorption and drug dissolution.

- On January 28, 2021, WHO released a road map for Neglected Tropical Diseases - “Ending the neglect to attain the Sustainable Development Goals: a road map for neglected tropical diseases 2021-2030”. The global target for 2030 is the implement strategies for prevention, control, elimination, and eradication of 20 diseases and disease groups and crosscutting targets broadly aligned to the Sustainable Development Goals (SDG’s). The aim of this road map is to increase in the number of countries with intensified control in hyperendemic areas, increasing from 2 (3%) in 2020 to 4 (6%) in 2023, to 9 (14%) by 2025, and to 17 (27%) by 2030.

Conclusion

Neurocysticercosis is a neglected tropical disease. It is a zoonotic disease and it is linked to poverty. It is a treatable and preventable disease with a good prognosis if diagnosed early. It requires a multimodal “One Health” approach.

Conflict of Interest

Not available

Financial Support

Not available

References

1. Gripper LB, Welburn SC. Neurocysticercosis infection and disease: a review. *Acta Trop.* 2017;166:218-224.
2. Mendlovic F, Fleury A, Flisser A. Zoonotic *Taenia* infections with focus on cysticercosis due to *Taenia solium* in swine and humans. *Res Vet Sci.* 2021;134:69-77.
3. Del Brutto OH, García HH. Cysticercosis of the human nervous system. Cham: Springer; 2014.
4. Butala C, Brook TM, Majekodunmi AO, Welburn SC. Neurocysticercosis: current perspectives on diagnosis and management. *Front Vet Sci.* 2021;8:5.
5. Gonzalez-Alcaide G, Sosa N, Shevy L, Belinchon-Romero I, Ramos-Rincon JM. Global research on cysticercosis and neurocysticercosis: a bibliometric analysis. *Front Vet Sci.* 2023;10:1156834.

How to Cite This Article

Karunyakaran DH. Neurocysticercosis: In’s and out’s. *International Journal of Veterinary Sciences and Animal Husbandry.* 2025;10(12):598-602.

Creative Commons (CC) License

This is an open-access journal, and articles are distributed under the terms of the Creative Commons Attribution-Non Commercial-Share Alike 4.0 International (CC BY-NC-SA 4.0) License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.