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Neurocysticercosis in the Era of Artificial Intelligence: Neuroanatomical Insights, Neuroimaging and Predictive Computational Neurology

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Abstract: *Neurocysticercosis (NCC), caused by the larval stage of Taenia solium, remains the most common parasitic infection of the central nervous system and a leading cause of acquired epilepsy worldwide. Despite substantial advances in neuroimaging, diagnosis and prognostic assessment remain challenging because of the heterogeneous clinical presentation and variable radiological features of the disease. Emerging developments in artificial intelligence (AI), radiomics, connectomics, and predictive computational neurology offer novel opportunities to improve diagnostic accuracy and individualised patient management. A structured literature search was conducted using PubMed, Scopus, Web of Science, and Google Scholar to identify peer-reviewed studies published between 2000 and 2025. The retrieved evidence was synthesised in a comprehensive narrative review focusing on the pathophysiology, neuroanatomical manifestations, neuroimaging characteristics and emerging computational applications in neurocysticercosis. Current evidence confirms the central role of computed tomography and magnetic resonance imaging in the diagnosis and staging of neurocysticercosis. Recent advances in radiomics, connectomics, machine learning, and deep learning demonstrate promising potential for improving lesion characterisation, differential diagnosis, quantitative imaging analysis, and prediction of neurological outcomes. Although disease-specific AI applications remain limited, computational methodologies successfully applied in neuroradiology, epilepsy, and neuro-oncology may be adapted to neurocysticercosis, supporting the development of predictive computational neurology and precision medicine. Neurocysticercosis represents a promising model for the future integration of neuroimaging, computational neuroscience, and artificial intelligence. However, current evidence remains limited by the scarcity of disease-specific datasets and the lack of large-scale clinical validation. Future multicenter studies integrating radiomics, connectomics, explainable AI, and standardised neuroimaging protocols will be essential for translating computational advances into clinically applicable diagnostic and prognostic tools capable of improving individualised neurological care.*

Keywords: *neurocysticercosis, artificial intelligence, computational neurology, epilepsy, neuroimaging, machine learning.*

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1. Introduction

Neurocysticercosis (NCC) is a parasitic infection of the central nervous system caused by the larval form of *Taenia solium* and remains one of the most important neuroinfectious diseases worldwide (Garcia et al., 2014). The disease constitutes a significant public health burden, particularly in low- and middle-income countries where inadequate sanitation, poor socioeconomic conditions, and limited access to healthcare facilitate transmission. Although traditionally associated with endemic regions of Latin America, Africa, and Asia, globalisation and migration have transformed neurocysticercosis into a worldwide neurological concern (Coyle et al., 2012). A recent review of neuroparasitic diseases has further emphasised that infections affecting the central nervous system continue to represent an important global health challenge because of their diverse neurological manifestations, diagnostic complexity, and long-term impact on morbidity. Among these disorders, neurocysticercosis remains one of the most clinically significant neuroparasitic infections worldwide (Moroșan et al., 2026).

The clinical importance of neurocysticercosis derives from its remarkable heterogeneity. Patients may remain asymptomatic for years, while others develop severe neurological manifestations including epilepsy, hydrocephalus, stroke, cognitive impairment, and psychiatric disorders (Del Brutto, 2012). The clinical presentation is influenced by numerous factors, including parasite burden, lesion location, developmental stage of the cysticerci, host immune response, and genetic susceptibility.

Advances in neuroimaging have dramatically improved diagnostic capabilities over the past decades. Computed tomography and magnetic resonance imaging have become essential tools for lesion identification, disease staging, and treatment monitoring (Nash & Garcia, 2011). Nevertheless, considerable diagnostic challenges remain, particularly when neurocysticercosis mimics neoplastic, inflammatory, or vascular disorders.

Simultaneously, artificial intelligence has emerged as one of the most transformative innovations in contemporary medicine. Machine learning algorithms, deep neural networks, radiomics, and computational neuroscience have demonstrated extraordinary potential for enhancing diagnostic precision and facilitating personalised healthcare (Topol, 2019). In neurological practice, artificial intelligence has already shown promising applications in epilepsy, stroke, neuro-oncology, and neurodegenerative diseases (Rajpurkar et al., 2022).

The combination of advanced neuroimaging, computational medicine, and artificial intelligence provides a unique opportunity to re-examine neurocysticercosis from a modern perspective. Given its heterogeneous radiological appearance, variable clinical manifestations, and complex neuroanatomical involvement, neurocysticercosis represents an ideal candidate for AI-assisted diagnostic and prognostic systems. Although artificial intelligence has shown remarkable success in several neuroradiological disorders, including brain tumours, stroke, and multiple sclerosis, disease-specific evidence in neurocysticercosis remains limited. Therefore, several computational approaches discussed in this review are extrapolated from related neurological conditions while highlighting their potential applicability to neurocysticercosis (Lambin et al., 2017; Robertson et al., 2025)

The study explores the intersection between parasitic neuroinvasion and computational neurology, emphasising how artificial intelligence may contribute to improved diagnosis, prediction of neurological outcomes, and development of precision medicine strategies.

2. Materials and Methods

This review aimed to synthesise current evidence regarding the pathophysiology, neuroanatomical manifestations, neuroimaging characteristics, and emerging artificial intelligence applications in neurocysticercosis.

A structured literature search was conducted using PubMed, Scopus, Web of Science, and Google Scholar to identify peer-reviewed publications published between 2000 and 2025. One earlier landmark publication (1983) was additionally included to provide historical context regarding the evolution of neuroradiological diagnosis. The retrieved evidence was synthesised in the form of a narrative review. Search terms included combinations of: “neurocysticercosis” OR “*Taenia solium*” AND (“epilepsy” OR “cognitive impairment” OR “stroke” OR “neuroinflammation” OR “neuroimaging”) AND ("artificial intelligence" OR "machine learning" OR "deep learning" OR "radiomics" OR "computational neurology" OR "medical image analysis").

Eligible publications included original research articles, systematic reviews, narrative reviews, meta-analyses, and clinical studies involving human or animal models of neurocysticercosis. Studies addressing central nervous system involvement, neuroradiological findings, neurological outcomes, computational neuroscience, radiomics, connectomics, and artificial intelligence-based diagnostic or predictive approaches were considered for inclusion.

Articles were excluded if they were not available in English, consisted solely of isolated case reports without broader scientific relevance, focused exclusively on extra-neural cysticercosis, or lacked relevance to neurocysticercosis, neurological manifestations, neuroimaging, or artificial intelligence applications.

Study selection was performed in two stages. First, titles and abstracts were screened for relevance. Subsequently, potentially eligible articles underwent full-text review. Data extracted included study design, patient population, sample size, neuroanatomical localisation, imaging findings, neurological outcomes, and AI-related methodologies when applicable. A total of 31 publications met the inclusion criteria and were included in the final review. This study is a narrative review designed to synthesise current evidence rather than a systematic review or meta-analysis. As this work represents a narrative review rather than a systematic review, the study selection process was not reported using a PRISMA flow diagram. Furthermore, formal quality assessment and risk-of-bias evaluation were not performed.

3. Results

3.1. Pathophysiology of Neurocysticercosis

The pathogenesis of neurocysticercosis begins with the ingestion of *Taenia solium* eggs through contaminated food, water, or direct faecal–oral transmission (White, 2000). Following intestinal digestion, oncospheres are released, penetrate the intestinal mucosa, and gain access to the bloodstream. Haematogenous dissemination subsequently allows migration to multiple organs, including skeletal muscle, subcutaneous tissue, eyes, and the central nervous system (Garcia et al., 2003).

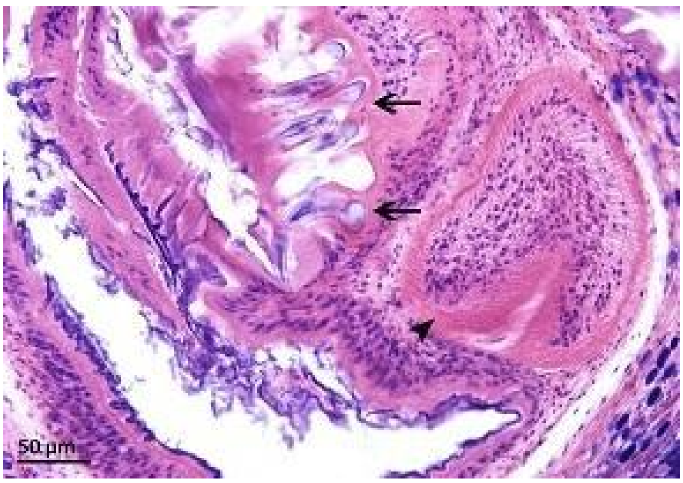

Figure 1. A). Microscopic features of T. solium cysticercus: the armed scolex (arrow) and convoluted spiral canal (darts) (H&E, x100); B). Closer view of the scolex portion of the T. solium cysticercus: the refractile hooks (arrows) and one sucker (dart) are visible (HE, x40) ((public domain, Centres for Disease Control and Prevention)

Within neural tissue, the larvae develop into cysticerci (see Figure 1) and undergo a complex biological evolution characterised by four principal stages: vesicular, colloidal, granular nodular, and calcified. Each stage exhibits distinct pathological and immunological characteristics that influence disease progression and clinical manifestations (Nash & Garcia, 2011).

The vesicular stage is characterised by viable cysticerci containing clear fluid and a visible scolex. During this phase, the parasite actively suppresses host immune responses, allowing prolonged survival within the brain. Consequently, inflammatory reactions are typically minimal, and many patients remain asymptomatic.

As degeneration begins, cysticerci enters the colloidal stage. This transition is associated with increased permeability of the cyst wall and release of parasitic antigens into surrounding neural tissue. The resulting immune activation triggers substantial inflammatory responses characterised by oedema, disruption of the blood–brain barrier, microglial activation, and infiltration of inflammatory cells (Garcia et al., 2014).

The subsequent granular nodular stage reflects progressive degeneration and fibrosis of the cyst. Although inflammatory activity gradually decreases, residual gliosis and tissue damage may persist. Ultimately, parasite destruction culminates in the calcified stage, during which residual calcified nodules remain embedded within neural tissue.

Historically, calcified lesions were considered biologically inactive. However, contemporary evidence suggests that they may continue to contribute to chronic neuroinflammation and epileptogenesis. Perilesional inflammatory episodes have been observed around calcified lesions, potentially explaining recurrent seizures in previously stable patients (Pal et al., 2000).

Recent studies increasingly highlight the importance of neuroimmune interactions in disease progression. Cytokines such as tumour necrosis factor-alpha, interleukin-1β, and interferon-gamma appear to contribute to neuronal hyperexcitability and structural remodelling of neural circuits. These mechanisms are now recognised as critical factors underlying seizure generation and chronic neurological dysfunction.

The complexity of these interactions has stimulated interest in computational modelling approaches. Machine learning algorithms may eventually facilitate the integration of immunological, radiological, and clinical biomarkers, enabling more accurate prediction of disease progression and treatment response.

3.2. Neuroanatomy and Clinical Manifestations

The neuroanatomical distribution of lesions represents one of the most important determinants of clinical presentation in neurocysticercosis.

Accurate interpretation of neuroimaging findings also requires detailed knowledge of cerebral neurovascular anatomy and its anatomical variations. Variations involving the anterior cerebral circulation may influence neuroradiological interpretation and neurosurgical planning, particularly when lesions are located adjacent to major vascular structures (Nedelcu et al., 2016).

Cysticerci may localise within the cerebral parenchyma, ventricular system, subarachnoid spaces, brainstem, cerebellum, and spinal cord, producing diverse neurological manifestations (Del Brutto et al., 2001). The complexity of cerebral anatomy extends beyond neural structures and includes considerable variability of the cerebral vasculature. Knowledge of these anatomical variants is important for both neuroradiological interpretation and neurosurgical planning, particularly when evaluating lesions located near major vascular territories (Nedelcu et al., 2016).

Parenchymal neurocysticercosis is the most common form of the disease. Lesions are frequently located within the cerebral cortex and subcortical white matter, particularly in the frontal and parietal lobes. Such localisation explains the strong association between neurocysticercosis and epilepsy. Indeed, NCC remains one of the leading causes of acquired epilepsy worldwide, accounting for a substantial proportion of seizure disorders in endemic regions (Garcia et al., 2014).

Frontal lobe involvement may result in executive dysfunction, impaired planning abilities, behavioural alterations, personality changes, and reduced cognitive flexibility. Because the prefrontal cortex plays a critical role in decision-making and emotional regulation, lesions affecting this region may contribute to neuropsychiatric manifestations that occasionally resemble primary psychiatric disorders (Moroșan et al., 2024).

Temporal lobe neurocysticercosis is particularly relevant because of the role of this region in memory formation, emotional processing, and language functions. Lesions involving mesial temporal structures may facilitate epileptogenesis through disruption of hippocampal circuitry and limbic networks. Patients may present with focal seizures, memory disturbances, emotional dysregulation, and, in rare cases, psychotic manifestations (Garcia et al., 2014).

Parietal lobe involvement may produce sensory deficits, disturbances of body perception, impaired spatial orientation, and difficulties in visuospatial integration. Depending on lesion location, patients may experience altered tactile perception or deficits in sensorimotor processing. Occipital lesions may result in visual field abnormalities, visual hallucinations, or impaired visual processing due to disruption of primary and associative visual cortices (Garcia et al., 2014; Del Brutto, 2012).

Subcortical white matter lesions may interfere with long-range communication pathways connecting cortical regions. Consequently, neurological dysfunction may extend beyond the immediate location of the parasite, affecting distributed neural networks involved in cognition, attention, and executive functioning (Garcia et al., 2014; Sporns, 2018).

Intraventricular neurocysticercosis represents one of the most severe forms of the disease. Cysticerci may localise within the lateral ventricles, third ventricle, or fourth ventricle, producing obstruction of cerebrospinal fluid circulation. Ventricular obstruction frequently leads to hydrocephalus, elevated intracranial pressure, headache, nausea, vomiting, gait disturbances, and potentially life-threatening neurological deterioration (Nash & Garcia, 2011).

Subarachnoid neurocysticercosis frequently involves the basal cisterns and meningeal structures. Chronic inflammation within these regions may result in arachnoiditis, fibrosis, cranial nerve dysfunction, and cerebrovascular complications. Inflammatory vasculopathy may contribute to ischemic stroke through narrowing or occlusion of cerebral arteries (Carpio et al., 2013).

Brainstem involvement, although less common, may generate particularly severe clinical manifestations because of the high density of critical neural pathways within this anatomical region. Cranial nerve deficits, dysphagia, motor weakness, impaired coordination, and respiratory dysfunction have all been reported in patients with brainstem neurocysticercosis.

Spinal neurocysticercosis remains relatively rare but may produce radiculopathy, myelopathy, sensory disturbances, and motor deficits. Lesions may occur within the spinal cord parenchyma or in the subarachnoid compartment, resulting in compression of neural structures and progressive neurological impairment.

Recent advances in functional neuroimaging have expanded understanding of the network-level consequences of neurocysticercosis. Beyond focal anatomical damage, lesions may disrupt large-scale neural circuits responsible for cognition, memory, emotional regulation, and motor control. Functional magnetic resonance imaging studies suggest that even localised inflammatory lesions may alter connectivity among distributed cortical and subcortical regions, contributing to persistent neurological and neuropsychiatric symptoms.

This network-based perspective has stimulated growing interest in connectomics and computational neuroscience. Artificial intelligence-assisted connectomic analyses may identify patterns of network dysfunction associated with epilepsy, cognitive decline, and long-term neurological outcomes. Consequently, neurocysticercosis should be understood not only as a focal parasitic infection but also as a disorder capable of affecting complex neural systems across multiple levels of brain organisation (Sporns, 2018).

3.3. Neuroimaging, Radiomics, and Artificial Intelligence in Neurocysticercosis

Neuroimaging constitutes the cornerstone of neurocysticercosis diagnosis and remains essential for lesion characterisation, disease staging, therapeutic planning, and longitudinal monitoring. The introduction of advanced imaging techniques has significantly improved understanding of the disease and facilitated more accurate differentiation from alternative neurological disorders (Nash & Garcia, 2011). The introduction of computed tomography marked a major advance in the diagnosis of neurocysticercosis by enabling the in vivo visualisation of characteristic intracranial lesions. One of the earliest landmark studies demonstrated that CT substantially improved lesion detection and disease characterisation, establishing neuroimaging as an essential component of the diagnostic evaluation of patients with neurocysticercosis (Minguetti & Ferreira, 1983). This pioneering work laid the foundation for the subsequent evolution of advanced MRI techniques, quantitative imaging, and artificial intelligence–assisted neuroradiology. Recent advances in artificial intelligence have introduced a broad spectrum of machine learning and deep learning architectures with potential applications in neurocysticercosis. Convolutional Neural Networks (CNNs) have demonstrated excellent performance in automated lesion detection and classification on CT and MRI by extracting hierarchical imaging features, making them particularly suitable for identifying calcified, vesicular, and ring-enhancing cystic lesions (LeCun et al., 2015; Litjens et al., 2017). More specialised CNN-based segmentation architectures such as U-Net enable accurate delineation of cyst boundaries, surrounding oedema, and ventricular involvement, facilitating objective lesion quantification and longitudinal monitoring (Ronneberger et al., 2015). Residual deep learning models such as ResNet improve diagnostic performance through deeper feature extraction while minimising gradient degradation, allowing differentiation of neurocysticercosis from other ring-enhancing lesions including tuberculomas, brain abscesses, and neoplasms (He et al., 2016).

Computed tomography (CT) remains highly sensitive for detecting calcified lesions and is often considered the preferred modality for identifying chronic stages of the disease. Calcifications typically appear as hyperdense nodules and may be associated with surrounding oedema during episodes of recurrent inflammation. In contrast, magnetic resonance imaging (MRI) provides superior visualisation of viable cysticerci, ventricular involvement, brainstem lesions, and subarachnoid disease (Nash & Garcia, 2011). MRI sequences such as T1-weighted, T2-weighted, FLAIR, diffusion-weighted imaging, and susceptibility-weighted imaging allow comprehensive evaluation of lesion morphology and inflammatory activity.

Recent advances in magnetic resonance imaging have further expanded the neuroradiological evaluation of neurocysticercosis (see Figure 2).

Advanced MRI techniques, including diffusion-weighted imaging, susceptibility-weighted imaging, diffusion tensor imaging, magnetic resonance spectroscopy, perfusion imaging, and functional MRI, provide complementary information regarding lesion composition, inflammatory activity, neural connectivity, and treatment response, thereby improving diagnostic accuracy and facilitating more comprehensive disease assessment (Batta et al., 2020).

Figure 2. MRI (Magnetic Resonance Imaging) of the brain: cystic lesion with a well-defined border, located in the cerebellum.

One of the most characteristic neuroradiological findings is the “hole-with-dot” sign, representing visualisation of the scolex within the cyst. This imaging feature is considered highly suggestive of neurocysticercosis and often facilitates diagnosis. Nevertheless, atypical lesions frequently create diagnostic uncertainty, particularly when differentiating NCC from gliomas, metastases, tuberculomas, pyogenic abscesses, toxoplasmosis, or demyelinating diseases (Garcia et al., 2014). Recent comprehensive reviews of neuroparasitic imaging have further emphasised the central role of structured neuroimaging algorithms in the evaluation of parasitic diseases affecting the central nervous system. Characteristic CT and MRI findings, interpreted within standardised diagnostic frameworks, facilitate the differentiation of neurocysticercosis from other infectious, inflammatory, vascular, and neoplastic intracranial lesions, thereby improving diagnostic confidence and clinical decision-making (Robertson et al., 2025).

Clinical evidence further emphasises the pivotal role of neuroimaging in the diagnosis of neurocysticercosis. In a study conducted among people with epilepsy in endemic regions of Tanzania, Makasi et al. (2025) demonstrated a significant correlation between serum cysticercosis screening and neuroimaging findings, highlighting the complementary value of integrating radiological and laboratory investigations to improve diagnostic accuracy. These findings further support the central role of neuroimaging in the comprehensive evaluation of patients with suspected neurocysticercosis.

Recent advances in quantitative imaging have introduced the field of radiomics, which has emerged as a bridge between conventional medical imaging and personalised medicine. Radiomics converts standard radiological images into high-dimensional quantitative datasets that can be analysed using advanced computational algorithms to identify imaging biomarkers associated with lesion heterogeneity, morphology, and biological behaviour (Lambin et al., 2017). Unlike traditional radiological interpretation, radiomics transforms medical images into quantitative information regarding texture, shape, intensity, and spatial relationships that may not be appreciable through visual inspection alone (Erickson et al., 2017).

Radiomics has demonstrated increasing relevance in neuro-oncology, stroke medicine, and neurodegenerative disorders. Similar applications may be extended to neurocysticercosis, where quantitative imaging biomarkers could facilitate lesion classification, assessment of inflammatory burden, prediction of disease progression, and monitoring of therapeutic response. The integration of radiomics with clinical and laboratory variables may provide a foundation for future precision medicine approaches.

Artificial intelligence represents a natural extension of these developments. Machine learning algorithms are particularly suited to the analysis of complex imaging datasets and may identify patterns beyond the capabilities of conventional statistical methods. In recent years, AI-assisted neuroradiology has become one of the fastest-growing areas of computational medicine (Esteva et al., 2019).

3.4. Deep Learning and Machine Learning Applications

Machine learning refers to a group of computational methods capable of identifying patterns within large datasets and generating predictive models. Unlike traditional statistical approaches, machine learning algorithms continuously improve their performance through exposure to additional data. This adaptability makes them particularly valuable in medical image analysis, where enormous quantities of information must be processed and interpreted (Erickson et al., 2017; Litjens et al., 2017; Rajpurkar et al., 2022).

Among the various machine learning architectures, convolutional neural networks (CNNs) have emerged as the most influential tools in neuroradiology. CNNs are specifically designed to analyse visual information and have demonstrated remarkable success in image classification, segmentation, and pattern recognition tasks (Litjens et al., 2017).

In neurocysticercosis, CNN-based systems may facilitate automated lesion detection and segmentation while simultaneously identifying subtle radiological characteristics associated with disease stage and inflammatory activity. By analysing thousands of imaging features simultaneously, deep learning algorithms may improve differentiation between viable cysticerci, degenerating lesions, and calcified nodules. Furthermore, these systems may assist clinicians in distinguishing neurocysticercosis from intracranial tumours, metastatic lesions, cerebral abscesses, and tuberculomas.

Although artificial intelligence applications specifically developed for neurocysticercosis remain relatively limited, early computational studies have demonstrated the feasibility of applying hybrid image-processing algorithms to improve lesion visualisation and differentiation from neoplastic brain lesions. These approaches illustrate the potential of computer-assisted medical image analysis as a foundation for more advanced machine learning and deep learning systems in neurocysticercosis (Rajalingam & Priya, 2019).

Recent studies in medical imaging suggest that deep learning algorithms can achieve diagnostic performance comparable to expert radiologists under certain conditions (Rajpurkar et al., 2022). Although similar large-scale investigations remain limited in neurocysticercosis, the disease represents an ideal candidate for future AI-based diagnostic systems because of its heterogeneous radiological appearance and substantial diagnostic variability.

Beyond lesion identification, artificial intelligence may contribute to automated quantification of perilesional oedema, ventricular enlargement, hydrocephalus severity, and treatment response. Such objective measurements could improve clinical decision-making and reduce interobserver variability (Erickson et al., 2017; Batta et al., 2020; Rajpurkar et al., 2022).

3.5. Connectomics and Network Neuroscience

Traditional descriptions of neurocysticercosis emphasise anatomical lesion location. However, contemporary neuroscience increasingly recognises that neurological disorders should also be understood in terms of neural network dysfunction.

Connectomics refers to the comprehensive study of structural and functional connectivity within the brain (Sporns, 2018). Modern neuroimaging techniques such as diffusion tensor imaging and functional MRI have demonstrated that focal lesions may influence neural networks far beyond their immediate anatomical boundaries.

In neurocysticercosis, cortical and subcortical lesions may disrupt communication among distributed brain regions involved in cognition, memory, emotional regulation, and sensorimotor integration. Such disruptions may contribute to epilepsy, cognitive decline, psychiatric symptoms, and persistent neurological dysfunction (Garcia et al., 2014; Sporns, 2018).

Artificial intelligence has become an essential tool for connectomic analysis because of the enormous complexity of connectivity datasets. Machine learning algorithms can simultaneously evaluate thousands of neural connections and identify patterns associated with specific clinical outcomes. These approaches may facilitate identification of novel biomarkers predictive of epilepsy severity, cognitive impairment, and treatment response (Sporns, 2018; Senders et al., 2018; Rajpurkar et al., 2022).

Graph theoretical analysis represents another promising area of investigation. By modelling the brain as a complex network of interconnected nodes, researchers may evaluate how parasitic lesions alter global network efficiency, information processing, and functional integration. Such insights may substantially improve understanding of disease-related neural reorganisation (Sporns, 2018).

3.6. Artificial Intelligence, Global Health, and Telemedicine

The burden of neurocysticercosis remains greatest in regions with limited access to specialised neurological care. Consequently, artificial intelligence may have particularly important applications in global health and resource-limited settings.

AI-assisted telemedicine platforms may facilitate remote interpretation of neuroimaging studies, automated lesion detection, and clinical decision support. Such technologies could substantially improve diagnostic accessibility in endemic regions where neuroradiologists and neurologists are scarce (Topol, 2019).

Machine learning algorithms may also contribute to epidemiological surveillance by analysing healthcare databases, environmental variables, migration patterns, and disease transmission dynamics. Predictive epidemiological models could assist public health authorities in identifying high-risk regions and implementing targeted prevention strategies.

Furthermore, mobile health applications incorporating artificial intelligence may support community-based screening programmes and facilitate earlier disease detection. These developments align with broader efforts to integrate computational medicine into global neurological care. The expanding role of digital technologies in neuroscience extends beyond diagnostic imaging and includes cognitive assessment, patient monitoring, and personalised therapeutic interventions. Recent studies have demonstrated the potential of computerised approaches to improve neurological and neuropsychiatric evaluation, supporting the broader integration of computational methods into clinical neuroscience (Moroșan et al., 2025).

3.7. Generative Artificial Intelligence and Clinical Decision Support

The recent emergence of generative artificial intelligence has introduced a new dimension to computational medicine. Large language models and generative AI systems have demonstrated impressive capabilities in natural language processing, information synthesis, medical education, and clinical decision support (Rajpurkar et al., 2022).

In neurological practice, generative AI may assist healthcare professionals by summarising medical literature, generating clinical reports, facilitating radiological interpretation, and supporting diagnostic reasoning. In the context of neurocysticercosis, these technologies may be particularly useful because diagnosis often requires the integration of complex information derived from epidemiology, neuroimaging, laboratory testing, and clinical presentation (Garcia et al., 2014; Rajpurkar et al., 2022).

Large language models may also support physicians practicing in resource-limited environments by providing rapid access to evidence-based recommendations and diagnostic guidelines. Such systems may enhance clinical efficiency and reduce diagnostic delays, particularly in regions where neurological expertise is scarce (Topol, 2019; Rajpurkar et al., 2022).

Moreover, generative AI may facilitate interdisciplinary communication among neurologists, radiologists, infectious disease specialists, neurosurgeons, and public health professionals. By integrating data from multiple sources into coherent clinical narratives, these systems may improve coordination of care and promote evidence-based decision-making (Topol, 2019; Rajpurkar et al., 2022).

Although promising, generative AI should be viewed as an assistive technology rather than a replacement for clinical judgment. Human oversight remains essential to ensure accuracy, ethical compliance, and patient safety (Topol, 2019; Esteva et al., 2019).

3.8. Predictive Computational Neurology and Precision Medicine

The emergence of predictive computational neurology represents one of the most significant developments in contemporary neuroscience. This discipline combines artificial intelligence, neuroimaging, clinical data, and computational modelling to generate individualised predictions regarding disease progression and neurological outcomes (Topol, 2019; Senders et al., 2018).

The concept of precision neurology has gained increasing attention in recent years. Rather than applying identical treatment strategies to all patients, precision neurology seeks to tailor therapeutic interventions according to individual biological characteristics. Artificial intelligence may play a central role in this process by identifying patient-specific risk profiles and predicting treatment responsiveness (Topol, 2019; Rajpurkar et al., 2022).

Radiomics-based predictive models are particularly promising in this regard. By converting conventional imaging findings into quantitative biomarkers, radiomics facilitates construction of highly sophisticated predictive algorithms capable of estimating disease severity and therapeutic outcomes (Senders et al., 2018). Such systems may ultimately support individualised treatment planning and improve long-term neurological prognosis.

Precision medicine has become one of the most important objectives of modern healthcare. Traditional therapeutic approaches often rely on generalised treatment protocols that may not adequately account for biological heterogeneity among patients. Precision medicine seeks to overcome these limitations by tailoring interventions according to individual genetic, molecular, radiological, and clinical characteristics.

Artificial intelligence is expected to play a fundamental role in the realisation of precision neurology. By integrating multimodal datasets, including neuroimaging findings, inflammatory biomarkers, genomic information, and clinical variables, AI systems may generate individualised disease profiles and therapeutic recommendations (Senders et al., 2018).

In neurocysticercosis, personalised medicine approaches may facilitate optimisation of antiparasitic therapy, corticosteroid administration, seizure management, and neurosurgical decision-making.

The integration of radiomics, connectomics, computational immunology, and artificial intelligence may ultimately transform neurocysticercosis into a model disease for precision neurological care.

4. Discussion

The present review highlights the increasing convergence of neuroinfectious disease research, advanced neuroimaging, and artificial intelligence in the study of neurocysticercosis. Despite considerable advances in understanding the pathophysiology and clinical manifestations of the disease, neurocysticercosis remains a significant diagnostic challenge because of its heterogeneous neuroanatomical distribution, variable radiological appearance, and broad spectrum of neurological presentations (Garcia et al., 2014; Nash & Garcia, 2011). Conventional neuroimaging, particularly computed tomography and magnetic resonance imaging, continues to represent the cornerstone of diagnosis, lesion staging, and therapeutic monitoring, while modern imaging techniques have substantially improved lesion detection and characterisation (Nash & Garcia, 2011; Batta et al., 2020; Robertson et al., 2025).

Recent developments in radiomics, machine learning, and deep learning have transformed medical image analysis by enabling the extraction of quantitative imaging biomarkers that extend beyond conventional visual interpretation (Erickson et al., 2017; Lambin et al., 2017; Litjens et al., 2017). Although direct artificial intelligence applications in neurocysticercosis remain relatively limited, available evidence suggests that computational methodologies successfully applied in neuroradiology and other neurological disorders could improve lesion classification, differential diagnosis, prognostic assessment, and treatment monitoring in patients with neurocysticercosis (Rajalingam & Priya, 2019; Rajpurkar et al., 2022). Similarly, recent studies combining neuroimaging with complementary diagnostic approaches further emphasise the central role of imaging in the diagnostic evaluation of neurocysticercosis (Makasi et al., 2025).

Another important finding emerging from the reviewed literature is the progressive transition from a lesion-centred perspective towards a network-based understanding of neurological dysfunction. Beyond focal structural abnormalities, neurocysticercosis may disrupt distributed neural networks involved in cognition, memory, and seizure generation, supporting the potential value of connectomics and predictive computational neurology for future disease characterisation (Sporns, 2018). Such approaches may facilitate individualised risk prediction and contribute to the development of precision neurology by integrating neuroimaging, clinical variables, and computational modelling (Senders et al., 2018).

Recent network-based neuroimaging studies suggest that neurological disorders should be interpreted as disturbances of distributed functional connectivity rather than isolated structural lesions. The integration of resting-state functional MRI with connectomic analyses and artificial intelligence may therefore improve identification of clinically relevant imaging biomarkers and support individualised neurological assessment (Mavroudis et al., 2026).

Despite these promising developments, several important challenges remain. Current AI applications in neurocysticercosis are limited by the scarcity of disease-specific datasets, variability in imaging protocols, and the need for robust external validation before widespread clinical implementation. Furthermore, issues related to algorithm transparency, explainability, data privacy, and equitable access remain essential considerations for the responsible integration of artificial intelligence into neurological practice (Topol, 2019; Esteva et al., 2019). Consequently, future multicentre collaborations involving standardised neuroimaging protocols and high-quality annotated datasets will be essential for translating computational advances into clinically applicable diagnostic and prognostic tools for neurocysticercosis.

Furthermore, substantial heterogeneity in imaging acquisition protocols, scanner characteristics, magnetic resonance imaging sequences, and computed tomography parameters complicates the reproducibility of radiomic feature extraction and reduces the transferability of predictive models between institutions (Lambin et al., 2017; Zwanenburg et al., 2020).

An additional limitation is the relative scarcity of neurocysticercosis-specific artificial intelligence studies. Much of the current evidence is extrapolated from advances achieved in neuroradiology, epilepsy, neuro-oncology, and other neurological disorders rather than from dedicated neurocysticercosis investigations. Consequently, although these computational approaches appear highly promising, their direct clinical applicability in neurocysticercosis requires further validation before widespread implementation (Lambin et al., 2017; Robertson et al., 2025).

Overall, the available evidence indicates that neurocysticercosis represents an excellent model for the future integration of neuroimaging, computational neuroscience, and artificial intelligence. Continued collaboration among neurologists, neuroradiologists, infectious disease specialists, and computational scientists will be fundamental for advancing precision neurology and improving the diagnosis, monitoring, and long-term management of this complex neuroinfectious disease.

5. Ethical Challenges, Generative Artificial Intelligence, and Future Directions

Despite the remarkable progress achieved in artificial intelligence and computational medicine, several ethical, technological, and regulatory challenges remain before these tools can be fully integrated into routine neurological practice. While AI-assisted systems offer substantial opportunities for improving diagnostic accuracy and clinical efficiency, concerns regarding transparency, reliability, bias, privacy, and equitable access continue to generate considerable debate within the scientific community (Topol, 2019).

One of the principal challenges involves algorithmic bias. Machine learning systems depend heavily on the quality and representativeness of the datasets used during training. Many contemporary AI models are developed using data obtained primarily from high-income countries, tertiary medical centres, and highly selected patient populations. Consequently, their performance may be reduced when applied to patients from endemic regions where neurocysticercosis is most prevalent (Rajpurkar et al., 2022). Such disparities may inadvertently contribute to diagnostic inequalities and limit the generalisability of computational models.

Although diagnostic performance remains important, clinicians must also understand how predictions are generated in order to establish trust and facilitate responsible clinical implementation. Explainable artificial intelligence (XAI) has therefore emerged as an important research field seeking to improve transparency and interpretability within medical AI systems (Esteva et al., 2019).

Data privacy and cybersecurity represent additional challenges. The development of AI-driven neurological platforms requires access to large volumes of sensitive clinical information, neuroimaging studies, laboratory results, and demographic data. Ensuring patient confidentiality while maintaining adequate data availability remains a complex balance. Future systems must comply with increasingly stringent ethical and legal requirements regarding health information protection (Topol, 2019; Esteva et al., 2019).

Furthermore, substantial differences in technological infrastructure may limit implementation in regions where neurocysticercosis remains endemic. Many healthcare systems continue to experience shortages of imaging equipment, digital infrastructure, trained personnel, and computational resources. Consequently, successful integration of artificial intelligence into neurocysticercosis management will require not only technological innovation but also investments in healthcare accessibility and education (Topol, 2019; Rajpurkar et al., 2022). Future research should prioritise the establishment of large multicentre neuroimaging databases integrating clinical, radiological, laboratory, and outcome data from patients with neurocysticercosis. Standardisation of neuroimaging acquisition protocols and radiomics workflows will be essential to improve reproducibility and facilitate reliable comparison across institutions (Zwanenburg et al., 2020; Lambin et al., 2017).

Emerging evidence also indicates that stress-related neuroplasticity and large-scale network reorganisation contribute to persistent neurological dysfunction. Integrating these neurobiological mechanisms with artificial intelligence and multimodal neuroimaging may facilitate the development of predictive computational models and precision neurology approaches applicable to complex neurological diseases, including neurocysticercosis (Mavroudis et al., 2026).

Emerging artificial intelligence approaches may enhance model transparency, improve clinical interpretability, and facilitate the safe integration of AI-assisted decision support into clinical practice (Esteva et al., 2019). In addition, federated learning offers a promising strategy for collaborative model development by enabling multiple institutions to train artificial intelligence algorithms without sharing sensitive patient data, thereby addressing privacy concerns while increasing dataset diversity (Sheller et al., 2020; Raza et al., 2025). The integration of standardised radiomics, connectomics, predictive computational neurology, and explainable AI may ultimately contribute to more accurate and individualised management of neurocysticercosis (Lambin et al., 2017; Zwanenburg et al., 2020).

6. Limitations

This review is limited by its narrative design and the absence of quantitative synthesis. In addition, evidence regarding direct AI applications in neurocysticercosis remains limited, and conclusions regarding future computational approaches are partially derived from advances reported in neuroradiology, neuro-oncology and medical image analysis.

7. Conclusion

Artificial intelligence represents a promising complement to conventional neuroimaging for the diagnosis, characterisation and prognostic assessment of neurocysticercosis. Advances in radiomics, connectomics, and predictive computational neurology may facilitate more individualised patient management in the future. However, current evidence remains limited by the scarcity of disease-specific datasets, the predominance of retrospective investigations, heterogeneous imaging protocols, and the lack of prospective multicentre validation studies. Consequently, artificial intelligence should currently be regarded as an emerging adjunct to clinical practice rather than a replacement for expert clinical and radiological judgement. Continued interdisciplinary collaboration and rigorous prospective validation will be essential before these technologies can be routinely incorporated into clinical management.

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