Toxoplasma and Neospora: Opposite sides of the same coin

Toxoplasma gondii and Neospora caninum are apicomplexan protozoa that inhabit the intestines of a variety of domestic and wild animals. Toxoplasma gondii infection carries significant zoonotic risk as well as potentially causing disease in the feline definitive host and abortion in sheep. Control of human toxoplasmosis is based predominantly on good hygiene and food preparation practice and much of the zoonotic risk can be mitigated through appropriate advice to clients. In comparison, Neospora caninum is a major cause of bovine abortion and economic loss to beef and dairy farmers but poses little or no zoonotic risk. Dogs can be clinically affected by infection and be a source of oocysts capable of causing abortion storms in cattle herds. Preventing feeding of unprocessed raw diets to cats and dogs and preventing their access to sheep and cattle feed stores will help to minimise the economic impact of these parasites. This article considers disease control measures, clinical presentations, diagnosis and treatment in affected cats and dogs.

Key words: Neospora, Toxoplasma, zoonosis, control

Introduction
Toxoplasma gondii and Neospora caninum are apicomplexan protozoa that inhabit the intestines of a variety of domestic and wild animals. They are closely related parasites, both with indirect life cycles and the potential to cause clinical disease in their definitive hosts. Their life cycles are similar, consisting of an asexual stage where multiplying tachyzoites eventually develop into bradyzoite tissue cysts in intermediate hosts, and a sexual stage where oocysts are produced in the intestinal tissue of the definitive host. The definitive hosts for T. gondii are felids, whereas dogs are presently the only definitive host known for N. caninum. Although they are closely related, they also exhibit important differences and this article explores the veterinary and zoonotic significance of these parasites.

Toxoplasma gondii
Toxoplasma gondii is one of the few parasites whose name is recognisable to the public and associated with zoonotic infection. T.gondii has the potential to cause significant human and animal disease. It is also the second most common cause of infectious ovine abortion. There is no effective preventative treatment or vaccine for cats or dogs, so hygiene and husbandry forms the basis of disease control.

Life cycle and transmission
Current evidence suggests that Toxoplasma gondii infects all mammals but only felids act as a definitive host, producing oocysts in the intestine that are then passed in the faeces (Boothroyd 2009). Although cats can be infected through faecal-oral ingestion of oocysts, they most commonly acquire the infection by ingestion of tissue cysts. This occurs through predation of intermediate hosts such as rodents and birds, by feeding on raw or undercooked meat from infected livestock or, less commonly, on aborted ovine material (Figure 1). Ingested cysts rupture as they pass through the digestive tract, releasing the infective bradyzoites within.

Asexual (extraintestinal) phase
These bradyzoites then infect the epithelium of the intestinal lumen, where they can shift to the rapidly dividing tachyzoite form of the parasite and disseminate in the blood or lymph throughout the body. The host immune response can temper replication, shifting back to the bradyzoite form which persist within tissue cysts (Figure 2). This completes the asexual (extraintestinal) phase of the life cycle which can occur in many mammalian species including rodents, dogs and humans.

Sexual (enteroepithelial) phase
This phase of the life cycle can only occur in cats. Ingested bradyzoites transform to merozoites and then micro- (male) and macro- (female) gametes within the cat’s intestinal tract. These form the unsporulated oocysts which are shed in the cat’s faeces for between three days and three weeks. Oocysts are not immediately infective and take 1–5 days to reach the infective sporulated stage (Figure 3). Intermediate hosts, including humans, can be infected either transplacentally or through consumption of oocysts.
The oocysts are easily disseminated into surface water where they can survive for several months, making water, humid soil or feedstuffs contaminated with cat faeces, sources of infection. Carnivorous intermediate hosts may also be infected through consumption of tissue cysts in raw or undercooked meat and this is a significant source of human infection.

Clinical signs in cats
Clinical toxoplasmosis is rare in cats because the vast majority of cats that are infected do not develop clinical disease. Kittens infected in utero can show signs of infection after birth and prenatal infections of kittens are frequently fatal. The reason for clinical manifestation in adult cats are not fully understood but it is thought to be linked with immunosuppression. This may be secondary the use of immunosuppressive drugs or viral pathogens such as FeLV and FIV.

Affected animals show a variety of signs. The initial enteroepithelial stage can cause gastrointestinal signs such as inappetence and small intestinal diarrhoea. The clinical signs caused by the extra-intestinal stage are dependent on the tissue which is infected and magnitude of tissue burden. General systemic clinical signs might be observed such as lethargy and fever. Commonly infected tissues are skeletal muscle, central nervous system, liver, lungs and eyes. Therefore, common clinical signs also include muscle pain, abdominal pain, jaundice and tachypnoea / dyspnoea. Uveitis and choriorretinitis are common and CNS signs, including seizures and ataxia, should also prompt consideration of toxoplasmosis.

Diagnosis and treatment in cats
Routine diagnostic blood tests might reveal evidence of tissue inflammation / dysfunction. When oocysts are shed by infected cats, it is in large numbers. However, oocyst shedding occurs for a short period of time, repeat shedding is infrequent and clinical toxoplasmosis is more often associated with disseminated disease that occurs following oocyst shedding. This, in combination with the small size of the oocysts (typically 12.5 x 10.5µm, thin shelled), makes detection by faecal examination difficult. Whilst cytotological identification of T. gondii bradyzoites or tachyzoites in tissue, effusion, bronchoalveolar lavage, aqueous humor or cerebrospinal fluid samples is indicative of infection, it is uncommon for the disease to be diagnosed in this way. Diagnosis is typically based on a combination of clinical signs and serum antibody detection. However, serology should be interpreted with care because clinical signs may develop before antibodies are present and not all cats with subclinical infections will display antibody titres. Also, antibodies may be present in the absence of clinical signs. IgG and IgM anti- T. gondii antibodies should be interpreted together with the clinical presentation. Positive IgM titres develop in 80% of cats one to four weeks post infection and are usually negative by 16 weeks after infection. Positive IgG titres develop three to four weeks post infection and peak two to four weeks after initial detection. A three to four-fold increase in IgG titre is consistent with infection. In recrudescence, there may be no increase in IgG titre and IgM titres may remain negative. IgG can be detected in the CSF and aqueous humor of both sub-clinically infected cats and those with clinical toxoplasmosis. IgM has only been detected in infected cats (Barrs 2013). Serology clearly has limitations as a diagnostic tool as antibody detection indicates exposure and not necessarily clinical disease. Results must be considered in conjunction with clinical signs, exclusion of other common differential diagnoses and a positive response to treatment. PCR testing is also a sensitive and specific option for infected tissues, aqueous humor and CSF samples and is most often used in conjunction with serology results. This combination is the most accurate way to diagnose ocular or CNS toxoplasmosis (Lappin 2014).

In clinical cases, treatment with clindamycin can be useful at 12.5mg per kg twice daily for up to four weeks. This can help to resolve clinical signs but does not eliminate infection. Clinical outcomes are improved if treatment is started early so speculative treatment is justified if clinical infection is strongly suspected. There is no evidence that treatment has any effect on oocyst shedding so use of antibiotics is contraindicated in cats not exhibiting clinical signs, irrelevant of their serological status.

Toxoplasmosis in dogs
In dogs, clinical toxoplasmosis is rare, with most cases reported secondary to immunosuppression. The respiratory, gastrointestinal and neuromuscular systems are most commonly affected resulting in pyrexia, vomiting, diarrhoea,