проф. д-р НАЗМИЕ АЛТЪНТАШ
УНИВЕРСИТЕТ „ЕГЕ”, ИЗМИР, ТУРЦИЯ

проф. д-р АЛИ ОСМАН КАРАБАБА
УНИВЕРСИТЕТ „ЕГЕ”, ИЗМИР, ТУРЦИЯ

доц. д-р ЧЕНГИЗ ДЕМИР
УНИВЕРСИТЕТ „ЕГЕ”, ИЗМИР, ТУРЦИЯ

ас. д-р НУРАЙ АЛТЪНТАШ
УНИВЕРСИТЕТ „ЕГЕ”, ИЗМИР, ТУРЦИЯ

ВЗАИМОДЕЙСТВИЕ НА ЗДРАВЕОПАЗВАНЕТО И БЕЗОПАСНОСТТА НА РАБОТНОТО МЯСТО С ПАРАЗИТНИ АГЕНТИ ВЪВ ВЕТЕРИНАРНАТА И ХУМАННА МЕДИЦИНА

OCCUPATIONAL HEALTH AND SAFETY WORKING WITH PARASITIC AGENTS IN ANIMAL AND HUMAN MEDICINE

Prof. Dr. NAZMIYE ALTINTAS
EGE UNIVERSITY, İZMIR, TURKEY

Prof. Dr. ALI OSMAN KARABABA
EGE UNIVERSITY, İZMIR, TURKEY

Associate Prof. Dr. CENGIZ DEMIR
EGE UNIVERSITY, İZMIR, TURKEY

Assictant Prof. Dr. NURAY ALTINTAS
EGE UNIVERSITY, İZMIR, TURKEY

Abstract: The risk of exposure to some of the parasitic agents (such as zoonotic agents) is quite common during experimental and laboratory work. Especially some professions such as veterinarians can have risk of exposure to zoonotic agents is inherent in the practice of veterinary medicine as well as health care workers providing patient care at the hospitals, clinical laboratories and during experimental researches. Even a small percentage of occupational injuries and diseases are reported, if the health workers are working animal models they can expose themselves to these agents. A number of parasites causes parasitic diseases. This paper provides a brief description of some of the relevant parasitic diseases (which include blood and tissue and intestinal protozoon and helminthic diseases; such as trypanosomiasis, toxoplasmosis, malaria, leishmaniasis, cryptosporidiasis, giardiasis, amoebiasis, schistosomiasis, echinococcosis) encountered by working in animal and human medicine.
Key Words: Occupational health and safety, parasitic disease, parasitic agent

INTRODUCTION

Persons working in research and clinical laboratories are at risk of becoming infected with parasites through accidental exposures. Some of the accidents that resulted in laboratory-acquired infection were directly linked to poor laboratory practices (recapping a needle or working barehanded etc.) and even persons who realize they have had a laboratory accident often do not know whether they truly were exposed to organisms and what the

inoculum size was and also how to monitor for infection after accidental exposures. Because of such uncertainties and the potential severity of some parasitic diseases even in immunocompetent persons, the first reactions to laboratory accidents often are confusion and anxiety (Herwaldt, 2001).

Because protozoa, in contrast to most helminths, multiply in the human host, even a small inoculum can cause illness. Few laboratory-acquired helminthic infections have been reported despite protozoan infections. The scarcity of such reports might reflect in part the fact that helminthic infections generally are less likely than protozoan infections to be acquired in the laboratory. Even if laboratorians became infected by ingesting infective eggs or through penetration of skin by infective larvae, they typically would have low worm burdens and few symptoms because most helminths do not multiply in humans (Abramowicz, 2000; Herwaldt, 2001)

Persons working with materials and agents that can cause systemic infection detectable by serologic testing according to different parasitic diseases. Serum should obtaine at the time of person, periodically thereafter (such as; every six months) to screen for asymptomatic infection, and after laboratory accidents it should be taken immediately after the accident and periodically thereafter (such as; 8 weeks continuously after infection or montly) and if clinical manifestations suggestive of parasitic infection develop.

To minimize the risk for accidental exposures, laboratorians working with parasites should use the containment conditions known as biosafety which are based on standard microbiological practices and incorporate personal protective equipment and biological safety cabinets when appropriate.

Parasites to which laboratory workers could be exposed to blood and tissue protozoa include *Trypanosoma* spp. (*Trypanosoma cruzi, T.brucei, T.rhodesiense, T.gambiense*), *Toxoplasma gondii, Plasmodium* spp., *Leishmania* spp. and intestinal protozoa include *Cryptosporidium parvum, Giardia lamblia, Entamoeba histolytica; and* to helminths include *Schistosoma* spp., *Strongyloides* spp., *Ancylostoma* spp., *Ascaris lumbricoides, Enterobius vermicularis, Fasciola hepatica, Taenia solium,* Hookworm and *Echinococcus granulosus.*

The purpose of this review is to get attention to laboratorians and health care workers and may be public if they are interested about the potential hazards of handling specimens with viable parasites and the diseases they can cause. So this paper will also provide a brief description of some of the relevant parasitic diseases in animal and human medicine.

A. BLOOD AND TİSSUE PROTOZOA

a) TRYPANOSOMIASIS

Trypanosoma cruzi causes the trypanosomiasis disease in humans and animals in America. Human American trypanosomiasis, or Chagas disease, is a potentially fatal disease of humans. Chagas disease is named after the Brazilian physician Carlos Chagas, who was the first to describe in 1909 this protozoon agent.The American form of trypanosomiasis is a serious public health problem in Central and South American countries (Kraus et al., 2003).

T.cruzi is found in the blood as a nonpropagating trypomastigote (Figure 1), after penetration into cells of the host it fifferentiates into amastigote form (Figure 2).

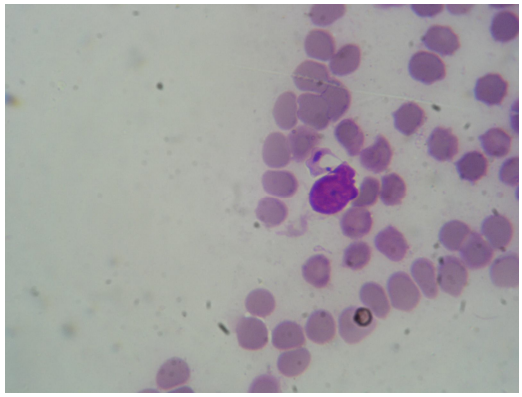

Figure 1. *Trypanosoma cruzi* trypomastigote (Original, N.Altintas).

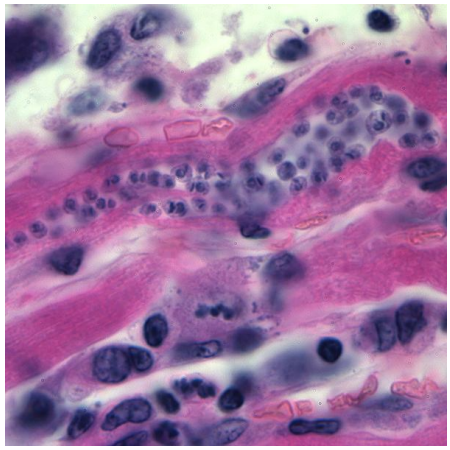

Figure 2. *Trypanosoma cruzi* amastigote (Center Disease Control, CDC).

Transmission occurs when the reduviid bug deposits feces on the skin surface and subsequently bites; the human host then scratches the bite area which facilitates penetration of the infected feces containing infective metacyclic trypomastigotes. The acute form usually goes unnoticed and may present as a localized swelling at the site of entry. The chronic form may develop 10 to 20 years after infection. This form affects internal organs (e.g. The heart, esophagus, colon and and the peripheral nervous system). Affected people may die from heart failure. Laboratorians can become infected through exposure to be feces of infected triatomine bugs, by handling cultures or blood specimens from infected persons or animals. So that's why especially research workers at the laboratory must be very careful. Because accidental puncture with a needle while working with animals is particularly common. In my personel experience when I was working with the parasite and had the laboratory accident in USA, after the accidental exposure my blood samples were taken 8 weeks and send to CDC for serological examinations.

b) TOXOPLASMOSIS

Toxoplasma gondii is a coccidian parasite which is the agent of toxoplasmosis disease. Infection with the protozoan *Toxoplasma gondii* is one of the most common parasitic infections of humans and in domestic and other wild animals worldwide. The host spectrum is extremely broad and includes warm-blooded animals. Domestic cats and other felines are the definitive hosts. Based on

seroepidemiological studies, the prevalence of infection with *T.gondii* in cats ranges between 10 and 80% (Dubey and Beattie, 1988; Kraus et al., 2003).

The life cycle of oocyst-transmitted infection has been studied in mice (Dubey et al., 1997a; Speer and Dubey, 1998). After ingestion of sporulated oocysts, sporozoites excyst, penetrate enterocytes and goblet cells of the intestinal epithelium, and are carried to the lamina propria via an unknown mechanism. Some sporozoites can be found circulating in peripheral blood as early as 4 h after ingestion. Infection can eventually spread to all other organs. According to some of the authors there is a very low chance that working with cats in veterinary practise or experimental research would result acquisition of *T.gondii* infection. It has been reported that cat ownership appears to be a higher risk for veterinerians to seroconvert than is working with cats in practise. Some of the authors reported that under laboratory conditions domestic cats shed millions of oocysts after feeding on one *T.gondii*-infected mouse (Dubey and Frenkel,1972; Fox et al., 1974; Tizard et al., 1976; Hill et al., 2001; Weese et al., 2002).

The main concern regarding *T.gondii* is its potential for zoonotic transmission to pregnant women. Acute infection in a previously uninfected pregnant woman can lead to congenital disease with retinochoroiditis, neurologic or systemic disease occuring in infant. Acute *T.gondii* infection can also lead to ocular lesions. In addition, *T.gondii* leads to a chronic infection that can reactivate causing severe or even fatal encephalitis or other systemic disease in immunocompromised persons. It has been found worldwide in nearly one-third of the human population. The prevalence in humans varies in different geographical areas, even within one country, and among different ethnic groups. The prevalence of human infections increases with age. The seropositivity rate in human populations is low in chidren up to 5 years age, but then it begins to increase and reaches its highest levels in the population 20 to 50 years old. The congenital toxoplasmosis is particularly important because of the severity of the sequelae in both the fetus and the newborn. There are three infectious stages of *T. gondii* for all hosts: tachyzoites (individually and in groups), bradyzoites (in tissue cysts), and sporozoites (in oocysts) (Kraus et al., 2003; Altintas, 2008; Jones and Dubey,2010).

All *Toxoplasma* isolates should be considered pathogenic for humans even if they are avirulent for mice. Laboratorians can become infected through ingestion of sporulated oocysts from feline fecal specimens or through skin or mucosal contact with either tachyzoites or bradyzoites in human or animal tissue or culture. Procedures for separating oocysts from feline feces and for infecting mice have been described; fecal flotations should be performed before oocysts sporulate and thus become infectious. Instruments and glassware that are contaminated with oocysts should be sterilized because oocysts are not readily killed by exposure to chemicals or the environment. There are the risk factors to become infected with *T.gondii* by laboratory workers, such as; needlestick injury, spillage onto skin, splash into an eye, working with viable parasites or performing the Sabin Feldman dye test which is a serologic test that uses live tachyzoites, a bite from an infected rabbit, and a cut with a coverslip containing infected tissue culture cells. Also risk to female veterinary personnel or laboratory personnel is through oral contact with cat feces (Herwaldt, 2001; Weese et al., 2002; Kraus et al., 2003).

c) MALARIA

Malaria is important human disease caused by various *Plasmodium* spp. The genus *Plasmodium* includes at least 172 named species that infect a wide range of mammals, birds, reptiles, and amphibians. *Plasmodium falciparum, P.vivax, P.ovale* and *P.malaria* commonly infect humans. All

malaria parasites are transmitted by female mosquitoes during blood meal. Congenital transmission and transmission by blood transfusion also occur. Patients who naturally acquired infection with simian *Plasmodium* spp. developed headacke, fever, fatigue, anorexia, nausea and hepatosplenomegaly (Kraus et al., 2003).

Thirtyfour cases of malaria in laboratorians and health care workers have been reported including six cases that were not published previously. At least 19 laboratory-acquired mosquito-borne (sporozoite-induced) cases have been reported, including at least 10 cases of *P. cynomolgi* infection, 5 cases of *P.vivax* infection, and 4 cases of *P.falciparum* infection. Fifteen cases acquired through accidental contact with infected blood have been reported (Herwaldt, 2001).

Laboratorians who dissect mosquitoes could become infected through subcutaneous injection of sporozoites. Another means of transmission to laboratorians and health care workers is through contact with infected blood from persons or animals or with cultured parasites, thus bypassing the hepatic stage of the parasite's life cycle. Laboratory personnel working with simian malaria should carefully adhere to rules of good laboratory practice when handling infected blood, isolated sporozoites or infected mosquitoes.

d) LEISHMANIASIS

The leishmaniasis are caused by 20 species pathogenic for humans belonging to the genus *Leishmania,* a protozoa transmitted by the bite of a tiny 2 to 3 millimetre-long insect vector, the Phlebotomine sand fly (Figure 3). The promastigote form of the parasite is found in the vector, and the amastigote form is found in macrophages in mammalian hosts (Figure 4). The major clinical syndromes are visceral leishmaniasis, which affects internal organs (e.g., spleen and bone marrow) and is life-threatening; cutaneous leishmaniasis, which causes skin lesions that can persist for months, sometimes years (Figure 5); and mucosal leishmaniasis, a sequela of New World (American) cutaneous leishmaniasis that involves the naso-oropharyngeal mucosa and can result in considerable morbidity. These infections are prevalent where sand fly vectors and mammalian reservoirs exist in sufficient numbers to permit frequent transmission. Depending on the leishmanial species, virulence, and tropism; on the specific vectors; and on the immun response of the host, visceral, cutaneous, and mucosal manifestations are induced by involvement of macrophages in various organ systems (Killick-Kendrick, 1999; Herwaldt, 1999; Kraus et al., 2003; Altintas, 2008).

Figure 3. Phlebotomine sand fly (Original, Yusuf Ozbel)

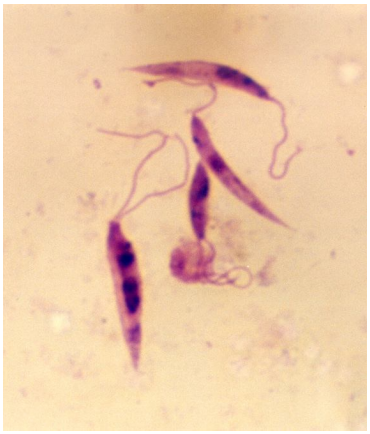

Figure 4. Promastigote form of *Leishmania infantum* (Original, Yusuf Ozbel)

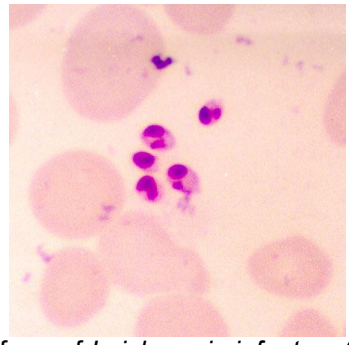

Figure 5. Amastigote form of *Leishmania infantum* (Original, Yusuf Ozbel)

In laboratory settings, leishmaniasis could be acquired through inadvertent contact with an infected sand fly. Transmission could also occur through contact with cultured parasites or specimens from infected persons or animals. Such as; through accidental needlestick injuries, recapping an infected needle, passaged suspensions of amastigotes in hamsters barehanded or by accidental selfinoculation while injecting an animal or via preexisting microabrasions of the skin. Blood specimens should be handled with care, even though fewer parasites generally are found in the bloodstream than in infected tissues. Twelve cases of laboratory-acquired leishmaniasis caused by six different species (*L.donovani, L.braziliensis, L.tropica,L.guyanensis, L.mexicana*, *L.amazonensis*) have been reported. Although most of the infected persons developed cutaneous leishmaniasis, sometimes with associated local lymphadenopathy, one person developed visceral leishmaniasis and one developed mucosal leishmaniasis as a sequela of cutaneous leishmaniasis (Herwaldt, 2001).

B. INTESTINAL PROTOZOA

Intestinal protozoa of potential concern to laboratorians include *Cryptosporidium parvum, Giardia intestinalis* and *E.histolytica.* They are infectious when excreted. Laboratory personnel should be careful working with stool specimens and fecally contaminated material. Even preserved specimens should be handled with care because if the specimens are inadequately preserved the parasites could still be viable.

a) CRYPTOSPORIDIASIS

Cryptosporidium spp. are common parasites of humans, domestic animals and

wild vertebrates. Cattle have been considered to be an important source of zoonotic cryptosporidiosis since the 1980s. Contact with infected calves has been implicated as the cause of many small cryptosporidiosis outbreaks in veterinary students, research technicians, and children attending agricultural camps and fairs. Environmental contamination with *Cryptosporidium* oocysts is problematic, especially for persons working with infected calves; during the peak period of shedding, infected calves shed billions of oocysts per day. Cases of cryptosporidiosis have been reported reported among persons exposed to experimentally infected animals and also occupational transmission from human patients to health care workers. Nasocomial patient-to-patient transmission of C.parvum in hospitals has also been reported. *Cryptosporidium parvum* infects primarily the intestinal epithelium but may be disseminated to epithelial cells of other organs. In immunocompetent persons, infection is frequently asyptomatic. Clinically overt disease develops after an ancubation period of 5 to 28 days. Symptoms are profuse watery diarrhea without blood, epigastric pain, nausea, anorexia, fever and weight loss. It occurs with more severe sypmtoms in particularly immunocompromised patients (Herwaldt, 1999; Kraus et al., 2003).

b) GIARDIASIS

Intestinal protozoa of potential concern to laboratorians include *Giardia intestinalis* which is the flagellated protozoan agent and caused giardiasis. It's an infectious gastrointestinal disease, predominantly of the small intestine. Giardiasis is a common cause of diarrheic disease in dogs and cats, especially amongst young animals. In a recent survey of fecal samples from 1216 dogs in 15 veterinary practices across Canada, 7.2% of samples were detected as seropositive, and 73% of infections occurred in animals less than 1 year of age.

Giardia infections of humans are diagnosed worldwide but it shows differentiation geographically. The infectious cysts of *Giardia* spp. are excreted in large numbers (such as severel million per day) in feces infected persons. Giardia cysts are immediately infectious upon excretion and do not need to sporulate in the environment (Figure 6). Cysts are also very resistant and able to survive for several weeks in the environment, resulting in a gradual increase in environmental infection pressure. They contaminate hands, drinking water and food. Human and animal feces used as fertilizer contaminate vegetables and fruits. The main clinical symptoms are a sudden onset of diarrhea accompanied by yellowish, foul-smelling stools without blood, mucus or pus; abdominal cramps; vomiting; anorexia; nausea; bloating with malodorous flatulence; and sometimes malaise, headacke and chills (Jacobs et al., 2001; Kraus et al., 2003; Geurden et al., 2010).

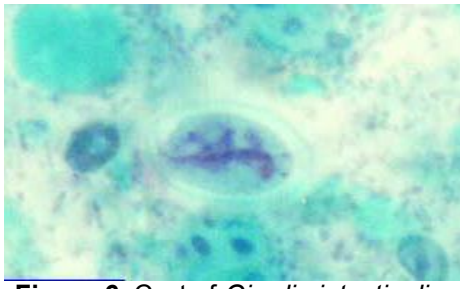

Figure 6. Cyst of *Giardia intestinalis*.

Giardia isolates are generally not highly host-specific. It is a common cause of diarrheic disease in dogs and cats, especially amongst young animals. Thus,

contact with dogs, cats, or both has been shown to be a significant risk for giardiasis in humans. Zoonotic transmission of *Giardia* from animals to humans involves ingestion of the cyst stage of the parasite in feces. Fecal samples from any dog and cat with acute or chronic diarrhea should be considered as potential sources of *Giardia* infection. Proper disposal of feces and handwashing should decrease the risk of zoonotic transmission. Monitoring of dogs and cats for *Giardia* infection should be part of a regular health check program. Laboratory workers who checked in several hundred stool survey specimens, stamping numbers and dates on report cards, many of which had been contaminated from leaky containers become infected with *G. intestinalis.* That's why laboratory personnel should observe routine precautions for work with stool specimens and fecally contaminated material, including careful hand washing after handling specimens. Even preserved specimens should be handled with care because parasites in inadequately preserved specimens could still be viable (Cook, 1961; Herwaldt, 2001; Weese et al., 2002).

c) AMOEBIASIS

Amoebiasis is an infectious disease caused by the intestinal protozoan parasite *E.histolytica.* Transmission occurs by oral ingestion of four nucleated cyst of *E.histolytica. E.histolytica* is estimated to infect about 50 million people worldwide. It is pathogenic and infection can lead to amoebic dysentery or amoebic liver abscess. The incubation period of amoebic dysentery varies. Usually 2 to 6 weeks after ingestion of amebic cysts acute invasive dysentery starts gradually, with mild gastrointestinal symptoms (such as diarrhea, sometimes constipation). Symptoms can include fulminating dysentery, bloody diarrhea, weight loss, fatigue, abdominal pain, and amoeboma. Amoebic liver abscess may also rupture into the peritoneal cavity and pericardium both associated with high mortality.

C. HELMINTHS

According to few reports helminthic infections generally are less likely than protozoan infections to be acquired in the laboratory. Even if laboratorians became infected by ingesting infective eggs or through penetration of skin by infective larvae, they typically would have low worm burdens and few, if any, symptoms Because most helminths do not multiply in humans. On the other hand, even preserved specimens should be handled with care because some helminth eggs can develop and could be viable in formalin (Garcia, 2001).

a) SCHISTOSOMIASIS

Schistosomiasis (also known as bilharzia, bilharziosis or snail fever) is a parasitic disease caused by several species of fluke of the genus *Schistosoma.* It is the second most socioeconomically devastating parasitic disease after malaria. This disease is most commonly found in Asia, Africa, and South America, especially in areas where the water contains numerous freshwater snails, which may carry the parasite. The disease affects many people in developing countries, particularly children who may acquire the disease by swimming or playing in infected water. It causes intestinal and urinary infections.

Laboratorians working with aquaria for snail intermediate hosts could become infected through skin penetration by schistosome cercaria, which swim freely, dissecting or crushing infected schistosome –infected snails could also result in exposure to droplets that contain cercaria. Therefore, laboratorians should wear gloves, a long-sleeved gown or coat to minimize the uncovered skin and also shoes rather than sandals during doing such work (Herwaldt, 2001).

b) ECHINOCOCCOSIS

Echinococcosis is a chronic disease of humans which has a serious prognosis and is caused by metacestodes of the genus

Echinococcus which include *E.granulosus*, *E.multilocularis*, *E.vogeli* or *E.oligarthrus* species. *E.granulosus* has a world wide distribution and occurs in all continents (Figure 7). *E.multilocularis* is distributed in the northern hemisphere. *E.vogeli* and *E.oligarthrus* are endemic in Central and South American countries. Larval infection (hydatid disease) is characterized by long-term growth of metacestode cysts in the intermediate host (Figure 8). *Echinococcus granulosus* and *E. multilocularis* - the two major species of medical and public health importance - cause cystic echinococcosis (CE) and alveolar echinococcosis (AE), respectively (Altintas, 2008).

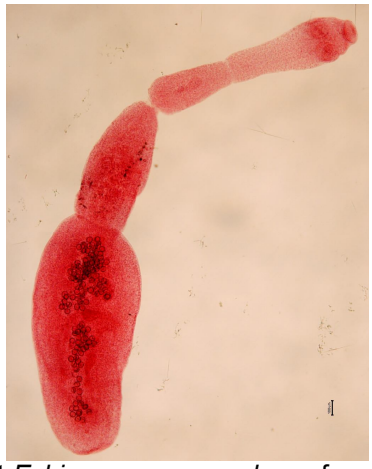

Figure 7. Adult *Echinococcus granulosus* from dog (Original).

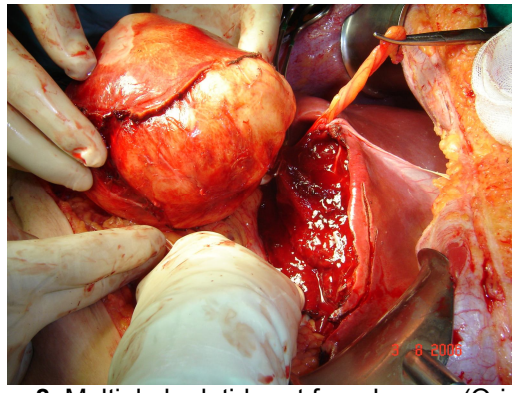

Figure 8. Multiple hydatid cyst from human (Original)

The prevalence of *E.granulosus* in final hosts varies with geographic areas. In some highly endemic regions, such as Mediterranean area up to 50% of dogs are found infected. The prevalence in Central Europe is less than 1%. Hundreds and thousands of adult *E.granulosus* may be present in the small intestine of a dog without clinical signs. A dog infected with *E.granulosus* produces approximately 8500 eggs per day. Eggs, passed in faeces, are highly infective to a variety of domestic/wild herbivores and omnivores, including humans. Humans are infected directly or indirectly from eggs excreted with dog faeces. In the intermediate host, hatched larvae (oncopheres) can produce a systemic disease, CE. CE may occur in laboratory animals. AE, is a potentially fatal disease that is confined to the northern hemisphere. Foxes are the usual definitive hosts and small mammals are intermediate

hosts. Humans, infected from eggs, develop a highly infiltrative metacestode almost exclusively in the liver, which in late stages, metastasizes to other organs. In many parts of the world, both CE and AE are emerging or reemerging zoonoses (Gemmell, 1990; Kraus et al., 2003; Altintas, 2008; Torgerson and Deplazes, 2009).

Diagnosis is a basic component of population studies on echinococcosis. Other than careful necropsy in animals, there is no perfect gold standard. In the definitive host, techniques for direct parasite identification include copro-antigen and copro-DNA detection. In intermediate hosts, necropsy is typically used. The sedimentation and counting technique is considered the gold standard and the most accurate quantitative method for both species of *Echinococcus*. The intestine is opened and incubated in physiological saline and the intestinal mucosa is scraped with a spatula. The released worms can be retrieved and counted from the sediment using a binocular microscope. The intestinal scraping technique is a less laboriousmethod formass screening and has a sensitivity that is 78%of that of the SCT. Deep mucosal scrapings (a total of 15 per intestine) are made using microscope slides, and these are squashed into thin layers and examined microscopically, enabling semiquantitative estimation of the worm burden. Safety precautions must be strictly followed when using either of these diagnostic strategies (Hofer, 2000; Eckert, 2001; Eckert, 2001a; Eckert, 2003).

CONCLUSION

Workplace injuries and illnesses range in severity and may cause short-term or long-term pain, disability or death. As well as the impact on their health, injured workers may also be absent from work, suffer loss of income or perhaps even loose their job.

Potential exposure to parasitic and especially zoonotic diseases is an inherent risk in health related professions with human and animals. It is almost impossible to completely protect themselves exposure to these agents, but measures can be taken to protect laboratory staff from acquiring infections. If attention is paid to awareness of disease with zoonotic potential, identification of infected animals, proper handling and housing, and personal hygiene, the risks to veterinary personnel and laboratory researchers can be greatly reduced. To decrease the accidental exposures, persons who will be working at the laboratory or research studies that could be exposed to pathogenic parasites must be attend to ongoing training programs and learn safety precautions before they begin to work. Such as; wearing gloves, wash hands frequently, use mechanical pipettors, do not recap needles, decontaminate work surfaces, and use biological safety cabinets when appropriate.

Although parasitic diseases generally are treatable, some infections are difficult to treat because of some of the reasons including drug-related toxicity, advanced disease (e.g.,mucosal leishmaniasis, cerebral malaria etc.), or host factors. Despite therapy, some parasites (*Toxoplasma gondii*) can persist for years in the body and can reactivate if the host becomes immunocompromised (Herwaldt, 2001).

REFERENCES:

1. Abramowicz, M. (ed.). (2000). Drugs for parasitic infections. Med. Lett. Drugs Ther. 2000(March):1–12. [Online.]
2. Altintas N. (2008). Parasitic zoonotic diseases in Turkey. Veterinaria Italiana, 44(4):633-646.
3. Cook, E. B. M. (1961). Safety in the public health laboratory. Public Health Rep. 76:51–56.
4. Dubey, J.P., and Frenkel J.K., (1972). Cyst-induced toxoplasmosis in cats. Journal of Protozoology. 19, 155-177.

5. Dubey, J.P., Beattie, C.P., (1988). Toxoplasmosis of Animals and Man. CRC Press, Boca Raton, 220 pp.
6. Dubey, J.P., Speer, C.A., Shen, S.K., Kwok, O.C.H., Blixt, J.A., (1997a). Oocyst-induced murine toxoplasmosis: life cycle, pathogenicity, and stage conversion in mice fed Toxoplasma gondii oocysts. J. Parasitol. 83, 870–882.
7. Eckert, J. et al. (2001) Echinococcosis in animals: clinical aspects, diagnosis and treatment. In WHO/OIE Manual on Echinococcosis in Humans and Animals: A Public Health Problem of Global Concern (Eckert, J. et al., eds), pp. 72–99, WHO/OIE
8. Eckert, J. et al. (2001a) Prevention of echinococcosis in humans and safety precautions. In WHO/OIE Manual on Echinococcosis in Humans and Animals: A Public Health Problem of Global Concern (Eckert, J. et al., eds), pp. 238–247, OIE and WHO
9. Eckert, J. (2003) Predictive values and quality control of techniques for the diagnosis of Echinococcus multilocularis in definitive hosts. Acta Trop. 85, 157–163
10. Fox JG, Campbell LH. (1974). Serological survey of toxoplasmosis in a selected population of veterinarians in California. Calif Vet, 28:32–35.
11. Garcia LS. (2001). Diagnostic medical parasitology. 4th ed. ASM Press, Wasington DC.
12. Geurden T, Vercruysse J, Claerebout E. (2010). Is Giardia a significant pathogen in production animals?. Experimental Parasitology, 124: 98–106.
13. Herwaldt, BL. (1999). Leishmaniasis. Lancet 354:1191–1199.
14. Herwaldt, BL. (2001). Laboratory-acquired parasitic infections from accidental exposures. Clinical Microbiology Reviews, 659–688.
15. Hill SL, Cheney JM, Taton-Allen GF, Reif JS, Bruns C, Lappin MR. (2000). Prevalence of enteric zoonotic organisms in cats. J Am Vet Med Assoc, 216:687–692.
16. Hofer, S. et al. (2000) High prevalence of Echinococcus multilocularis in urban red foxes (Vulpes vulpes) and voles (Arvicola terrestris) in the city of Zurich, Switzerland. Parasitology 120, 135–142
17. Jacobs SR, Forrester CP, Yang J. (2001). A survey of the prevalence of *Giardia* in dogs presented to Canadian veterinary practices. Can Vet J, 42:45–46.
18. Jones JL and Dubey JP. (2010). Waterborne toxoplasmosis- Recent developments. Experimental Parasitology 124, 10-25.
19. Krauss H, Weber A, Appel M, Enders B, Isenberg HD, Schiefer HG, Slenczka W, Graevenitz A von, Zahner H. (2003). Zoonoses : Infectious Diseases Transmissible from Animals to Humans, Third Edition, ASM Press.
20. Speer, C.A., Dubey, J.P., (1998). Ultrastructure of early stages of infection in mice fed Toxoplasma gondii oocysts. Parasitology 116, 35–42.
21. Tizard IR, Caoili FA. Toxoplasmosis in veterinarians: an investigation into possible sources of infection. Can Vet J 1976; 17:24–25.
22. Torgerson PR and Deplazes P. (2009). Echinococcosis: diagnosis and diagnostic interpretation in population studies. Trends in Parasitology 25 (4):164-170.
23. Weese JS, Peregrine AS and Armstrong J. (2002). Occupational health and safety in small animal veterinary practise: Part II-Parasitic zoonotic diseases. Can Vet J, 43 (October):799-802.

Настоящата статия е разработена в рамките на Проект „ROWER" финансиран по 7-ма Рамкова програма за научни изследвания на Европейския съюз и е представена на международната научна конференция „Икономически и социални въздействия на здравеопазването и безопасността на работното място.

The present article was worked out within the frames of the "ROWER" Project funded under the EU 7th Framework Programme for scientific research and it was presented on the international scientific conference "The Economic and Social Implications of Health and Safety at Work", held in Milan, Italy 2-3 July 2010.