Veterinary Parasitology 213 (2015) 172–181

Contents lists available at ScienceDirect

Veterinary Parasitology

journal homepage: www.elsevier.com/locate/vetpar

Present status, actions taken and future considerations due to the findings of *E. multilocularis* in two Scandinavian countries

Helene Wahlström[a,*], Heidi L. Enemark[b], Rebecca K. Davidson[c], Antti Oksanen[d]

[a] Zoonosiscenter, National Veterinary Institute, Uppsala, Sweden
[b] Section for Bacteriology, Pathology and Parasitology, National Veterinary Institute, Copenhagen, Denmark
[c] Section for Parasitology, Norwegian Veterinary Institute, Oslo, Norway
[d] Production Animal and Wildlife Health Research Unit, Finnish Food Safety Authority Evira (FINPAR), Oulu, Finland

ARTICLE INFO

Keywords:
Echinococcus multilocularis
Risk management
Surveillance
Costs
Denmark
Finland
Norway
Sweden

ABSTRACT

When *Echinococcus* (*E.*) *multilocularis* was first detected in mainland Scandinavia in Denmark in 2000, surveillance was initiated/intensified in Sweden, mainland Norway and Finland. After 10 years of surveillance these countries all fulfilled the requirements of freedom from *E. multilocularis* as defined by the EU, i.e. a prevalence in final hosts <1% with 95% confidence level. However, in 2011 *E. multilocularis* was detected in Sweden for the first time and surveillance was increased in all four countries. Finland and mainland Norway are currently considered free from *E. multilocularis*, whereas the prevalence in foxes in Sweden and Denmark is approximately 0.1% and 1.0%, respectively. *E. multilocularis* has been found in foxes from three different areas in Denmark: Copenhagen (2000), Højer (2012–14) and Grindsted (2014). Unlike Sweden, Norway and Finland, human alveolar echinococcosis (AE) is not notifiable in Denmark, and the number of human cases is therefore unknown. In Sweden, *E. multilocularis* has been found in foxes in four counties, Västra Götaland, Södermanland, Dalarna (2011) and Småland (2014). *E. multilocularis* has also been found in an intermediate host in Södermanland (2014). Two cases of AE have been reported in humans (2012), both infected abroad. No cases of *E. multilocularis* or AE have been reported in Finland and Norway. Recommendations and future considerations are discussed further.

1. Background

Apart from the finding in 1999 of *Echinococcus multilocularis* in the high-arctic island of Svalbard (Henttonen et al., 2001) the first case of *E. multilocularis* in the Nordic countries was found in a traffic-killed fox from Tåstrup, a western suburb of Copenhagen in 2000 (Kapel and Saeed, 2000). In 1994, serological investigations using the metacestode stage Em2 antigen (Gottstein et al., 1991) had indicated, but not definitively proved, the presence of the parasite. Following the Danish find in 2000, surveillance was initiated in Norway and Sweden and was intensified in Finland (Madslien et al., 2014; Wahlström et al., 2011) whereas no further Danish studies were conducted until 2011. After 10 years of surveillance in Sweden, the first positive fox was detected (Osterman Lind et al., 2011). The parasite has not been found in Norway, apart from on Svalbard, or in Finland (Henttonen et al., 2001; EFSA, 2013; Madslien et al., 2014).

Detection of *Echinococcus* spp. in animals is notifiable in all Scandinavian countries which is not the case for alveolar echinococcosis (AE) in humans. In Denmark, AE in humans is not notifiable. However, data concerning serological detection of *Echinococcus* spp. are available from the National Public Health Laboratory upon request (Henrik Vedel Nielsen, Statens Seruminstitut, pers. comm. 2014). In Sweden, Norway and Finland, human AE has been notifiable since 2004, 2003 and 1995, respectively (Anonymous, 2013; Folkehelseinstituttet, 2014) yet, information on species level is not required. In Sweden, notification from laboratories has been in place on a voluntary basis since 1994 (Anonymous, 2002). Species information based on laboratory results, clinical and radiological findings and epidemiology has when available been summarised (Anonymous, 2014a).

Import requirements to prevent introduction of *E. multilocularis* by dogs entering from EU-countries not free from the infection have been in place in most Scandinavian countries. However, since Denmark has never been officially free of *E. multilocularis* such requirements have never been in place in this country. Yet, from

* Corresponding author. Present address: Norwegian Defence Research Establishment, Kjeller, Norway. Fax: +46 18 674445.
E-mail address: helen.wahlstrom@sva.se (H. Wahlström).

http://dx.doi.org/10.1016/j.vetpar.2015.07.037
0304-4017/

February 2013, the Danish Veterinary and Food Administration has recommended that dogs are dewormed prior to entering Denmark if they are imported from, or have been visiting, high endemic areas in central Europe. In Sweden, prior to 1994 all imported dogs were dewormed in quarantine. In 1994, quarantine for dogs from EU countries was replaced with import requirements including that a veterinary deworming certificate should be presented at the border. Since this year, the number of imported dogs has increased substantially. In 1995, border control was relaxed and it is considered that compliance with import requirements consequently decreased (Maria Cedersmyg, Swedish Board of Agriculture, pers. com, 2014). In 2012, the requirement to deworm pets prior to entering Sweden was abolished as a consequence of the finding of *E. multilocularis* in foxes (Anonymous, 2014c). Norway also had strict quarantine regulations requiring deworming of dogs whilst in quarantine. In 1997, quarantine for pets travelling from EU countries was replaced by a requirement to show a veterinary deworming certificate at the border (exemption if travelling from *E. multilocularis*-free countries) and a recommendation that a second deworming should be done after entry. Nevertheless, the border control of travelling pets is limited. Since March 2011, after the findings of *E. multilocularis* in Sweden, deworming was also required of dogs entering from Sweden, but no veterinary certificate was required to certify that deworming had been done. In 2012, the recommendation of a second deworming after entry was abolished. Finland had quarantine requirements until 1994 but, since 2001 there is a requirement that, for dogs imported from EU countries that are not "*E. multilocularis*-free", a veterinary deworming certificate should be shown at the border. Since 1995, as in Sweden, border controls were relaxed due to the principle of free movement in the EU. From 2012 onwards, the deworming requirement also applies to dogs imported from Sweden (Virva Valle, Finnish Food Safety Authority Evira, pers. comm, 2014).

Current legislation is believed to have resulted in an increased risk of importing *E. multilocularis* to countries considered free from this parasite (Defra, 2010). Furthermore, spot checks by the Norwegian Food Safety Authority and a study by the Norwegian Veterinary Institute have revealed lack of compliance with the anthelmintic treatment requirements (Davidson and Robertson, 2012; Hamnes et al., 2013; VKM, 2012).

The aim of this article is to summarise the present veterinary situation concerning *E. multilocularis* in Denmark, Sweden, Norway and Finland and to discuss differences in surveillance, costs for surveillance, actions taken and future considerations including human AE in the four countries.

Table 1
Number of foxes/fox scats collected and anlaysed for *Echinococcus multilocularis* between 2000 and 2013 in Denmark, Sweden, Norway and Finland and type of analysis performed. References to methods used are given in the main text.

	Denmark	Sweden	Norway	Finland
2000	0	11[b]	0	9[f]
2001	0	442[b]	0	13[f]
2002	1040[a]	313[b]	85[d]	116[f]
2003	0	400[b]	119[d]	164[f]
2004	0	400[b]	105[d,e]	348[f]
2005	0	200[b]	5[d]	281[f]
2006	0	402[b]	31[e]	209[f]
2007	0	245[b]	539[e]	264[f]
2008	0	244[b]	455[e]	411[f]
2009	0	305[b]	280[e]	184[f]
2010	0	304[b,c]	0	144[f]
2011	287[a]	3775[c]	533[e]	128[f]
2012	262[a]	661[c]	614[e]	234[f]
2013	214[a]	1537[c]	625[c]	254[c,f]

[a] Sedimentation and counting technique.
[b] Coproantigen ELISA (CoA) and the segmental sedimentation and counting technique (SSCT as confirmatory test.
[c] MC-PCR.
[d] CoA and egg PCR as confirmatory test.
[e] Egg PCR.
[f] Coproantigen ELISA (CoA) and SCT as confirmatory test.

Table 2
Number of raccoon dogs collected and anlaysed for *Echinococcus multilocularis* between 2000 and 2013 in Denmark, Sweden, Norway and Finland and type of analysis performed. References to methods used are given in the main text.

	Denmark	Sweden	Norway	Finland
2000	0	0	0	0
2001	0	0	0	2[c]
2002	0	0	0	3[c]
2003	0	0	0	98[c]
2004	0	0	0	239[c]
2005	0	0	0	219[c]
2006	0	0	0	193[c]
2007	0	0	1[b]	227[c]
2008	0	21[a]	0	148[d]
2009	0	28[a]	0	177[d]
2010	0	0	0	166[d]
2011	85[a]	0	1[b]	204[d]
2012	49[a]	0	0	259[d]
2013	70[a]	0	0	418[e]

[a] Sedimentation and counting technique.
[b] Egg PCR.
[c] Coproantigen ELISA (CoA) and SCT as confirmatory test.
[d] CoA and egg PCR as confirmatory test.
[e] MC-PCR.

2. Methods

2.1. DENMARK

2.1.1. Surveillance in animals

Until the national surveillance of *E. multilocularis* in wild carnivores was initiated in 2011, prevalence studies of *E. multilocularis* were few. During the period 1997–2002, a total of 1040 red foxes (*Vulpes vulpes*) were examined from all regions of the country. Of these animals, 340 foxes originated from the greater Copenhagen area. A national surveillance program was initiated in autumn 2011 including approximately 300 wild carnivores each year, mainly foxes and raccoon dogs (*Nyctereutes procyonoides*) collected throughout the country (Tables 1 and 2). Until now (November 2014), a total of 1500 carnivores have been analysed. Studies of foxes and other wild carnivores in Denmark have so far used the sedimentation and counting technique (SCT) (Eckert et al., 2001) to detect *E. multilocularis*. Following morphological identification of *E. multilocularis*, the worms are further characterised by PCR (Knapp et al., 2007; Stefanic et al., 2004). Taeniid infections in intermediate hosts were studied in 719 small mammals trapped in and around the metropolitan area of Copenhagen in 2005–2009 (Al-Sabi et al., 2013). During autopsy visible lesions in the peritoneal cavity and liver underwent morphological analysis, and were subsequently analysed by PCR and sequencing (Al-Sabi and Kapel, 2011). No proper prevalence studies have been performed in Danish pets but faecal samples from Danish dogs ($n = 517$) and cats ($n = 169$) submitted to a diagnostic German laboratory in 2004–05 underwent PCR analysis for *E. multilocularis* as part of the routine diagnostic procedure (Dyachenko et al., 2008).

2.1.2. Risk assessment

The risk of introducing *E. multilocularis* to Sweden by Danish dogs and cats in transit was assessed by the National Veterinary Institute in Denmark in 2006 on the request of the Danish Veterinary and Food Administration (Bødker et al., 2007).