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Challenges and opportunities in detecting *Taenia solium* tapeworm carriers in Los Angeles County California, 2009—2014

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Abstract Carriers of the pork tapeworm, *Taenia solium*, are the sole source of neurocysticercosis, a parasitic tissue infection that can be chronic and severe. Identifying *T. solium* tapeworm carriers is challenging. Many are asymptomatic and go undetected and unreported. In addition, *T. solium* is difficult to distinguish from other *Taenia* species of less concern. From 2009 to 2014, 24 taeniasis cases were reported to the Los Angeles County (LAC) Department of Public Health. Twenty reports were received solely from our automated electronic laboratory reporting system (ELR), two from health care providers, and two were generated internally from investigation of households with a reported neurocysticercosis case. Further investigation identified one *T. solium* carrier originally reported by ELR and one identified from a neurocysticercosis case investigation. These results suggest that *T. solium* tapeworm carriers can be identified from investigation of ELR reports of unspeciated *Taenia* cases as well as from households of neurocysticercosis cases.

1. Introduction

Carriers of the pork tapeworm, *Taenia solium*, are the sole source of cysticercosis, a parasitic tissue infection [1]. When tapeworm eggs excreted by the carrier are ingested, tapeworm larvae can form cysts. When cysts form in the brain, the condition is called neurocysticercosis and can be especially severe. The burden of neurocysticercosis in Los Angeles County (LAC) is appreciable, with an average of 136 county residents hospitalized annually [2]. The prevalence of *T. solium* carriage is largely unknown because carriers are generally asymptomatic, making detection difficult. The identification and treatment of tapeworm carriers is an important public health measure that can prevent further neurocysticercosis cases [1].

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An increase in *Taenia* reports solely from our automated electronic laboratory reporting system (ELR) has recently been recognized. These cases were not identified by a LAC Department of Public Health (DPH) neurocysticercosis investigation, which has been the source of such reports in the past [3]. These ELR reports are generally based on the identification of *Taenia* eggs which are morphologically indistinguishable between *Taenia* species. Therefore, ELR reported *Taenia* cases may not be the species of public health interest (*T. solium*). Speciation can be performed at our public health laboratory, but can be challenging.

We performed a retrospective review of all taeniasis cases reported over the last 6 years in LAC. Case demographics, laboratory information and reporting source were reviewed.

2. Methods

Cases reported to the LAC DPH from 2009 to 2014 with supportive laboratory documentation were identified for review. Laboratory supportive evidence included (1) *Taenia* eggs identified via microscopy exam of stool performed at a private or our public health laboratory or (2) serological testing for *T. solium* antibodies specific for the tapeworm form using Enzyme-linked Immune-electro Transfer Blot (EITB) performed at the Center for Disease Control (CDC). Taeniasis case demographics and rates were calculated using population data provided by Urban Research [4], excluding LAC regions of Pasadena and Long Beach which are served by their own respective health departments. *Taenia* speciation, reporting source and birth place of cases were also reviewed. Medical, laboratory and DPH nursing records were reviewed where available. All effort was made to protect the personal health information of cases and all data were analyzed anonymously.

3. Results

3.1. Demographics (*N* = 24)

There were 24 taeniasis cases identified in LAC from 2009 to 2014, with an average annual rate of 4.1 per 10 million residents. Cases were much more likely to be male than female (79.2% vs. 20.8%) (Table 1). The average age of a case was 43.0 years (range 3—70 years). Many cases were Hispanic (37.5%) and a majority resided in the San Fernando Service Planning Area (58.3%). The annual rate of taeniasis was higher for men (6.5 per 10 million) and for persons age 35—44 years (9.5 per 10 million) and persons age 65 years and older (8.3 per 10 million). Asians had the highest rate of taeniasis by race ethnicity (7.7 per 10 million) and the San Fernando Valley Service Planning Area of LAC had the highest rate by geographic region (10.6 per 10 million).

3.2. Epidemiology (*n* = 14)

Prior to 2011, only basic demographic and testing information was captured with the taeniasis survey tool utilized. The survey tool was updated in 2011 and detailed birthplace, symptoms, treatment and employment information for the 14 cases occurring after this change. Of these, 13 were born outside of the US; Mexico (*n* = 6), Cuba (*n* = 1), Nicaragua (*n* = 1), Vietnam (*n* = 1), Italy (*n* = 1), Ethiopia (*n* = 1) Iran (*n* = 1) and Guatemala (*n* = 1). The one US born case frequently traveled to South East Asia for business trips. The average time for a case to have lived in the US before being diagnosed was 11 years (ranging 0—36 years). None of these cases were employed as a food handler.

Mild gastrointestinal symptoms were reported by seven of the 14 cases (i.e. stomach cramps, nausea). Of the seven cases that did not report gastrointestinal symptoms, four observed ''worms in their stool'' and sought medical attention. All 14 cases received treatment, which included praziquantel (*n* = 13) and albendazole (*n* = 1) and mebendazole (*n* = 1), with one case receiving multiple treatments over a two-year period. This case was initially treated with praziquantel (600 mg) followed by two additional treatments with albendazole (100 mg both times) from a private provider and a forth treatment of praziquantel (600 mg) from a county clinic. The case reported no worms one year after the fourth treatment, but declined further stool testing. The case reported no travel outside the US during this two-year period.

3.3. DPH notification source (*N* = 24)

Twenty of the 24 taeniasis cases were reported solely by ELR (83.3%). No health care provider notification was ever submitted. Further investigation of these ELR reports identified one *T. solium* case. This was a 60 year-old male who had emigrated from Ethiopia 20 years earlier and was reported with *Taenia* eggs in one of three stool specimens tested by a private lab. Three additional stool specimens collected from this case and tested at the public health lab identified a *T. solium* proglottid in one specimen. This case reported abdominal pain and was diagnosed with distention. Treatment consisted of a single dose of praziquantel (600 mg).