Cysticercosis: First 12 Months of Reporting in California[1]

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Cysticercosis, a sometimes fatal ailment caused by larvae of the pork tapeworm Taenia solium, *became a reportable disease in California in 1989. During the first year, from 1 April 1989 through 31 March 1990, 134 cases were reported to the California Department of Health Services.*

All of the 112 patients for whom laboratory diagnostic test data were obtained had neurocysticercosis. Nearly all (117) of the 127 patients whose race and ethnic background were known had a Hispanic background, and most of the 112 patients whose country of birth or prior residence was known had immigrated from T. solium*-endemic countries. However, three of 11 patients born in the United States said they had never traveled outside the country, and it appears possible that indigenous transmission has been occurring.*

These findings affirm that neurocysticercosis should be included in the differential diagnosis of neurologic symptoms in patients who have immigrated from or traveled to T. solium*-endemic countries, and also in those who have been in close contact with immigrants from endemic countries.*

Cysticercosis, a potentially fatal disease caused by larvae of the pork tapeworm *Taenia solium*, became a reportable disease in California on 1 April 1989. *T. solium* infects both swine (causing swine cysticercosis) and man, the latter serving as both an intermediate and definitive host.

Infection of man as the definitive host (taeniasis) occurs when a person ingests the larval stage in raw or undercooked pork. The larva then develops into an adult tapeworm in the jejunum. Symptoms of such an infection, limited to the gastrointestinal tract, are usually mild or absent. However, someone infected with a *T. solium* tapeworm, which may persist for several years, is a potential transmitter of cysticercosis. Such a person may release as many as 50,000 eggs per day in his stools (*1*).

Infection of man as the intermediate host (cysticercosis) occurs after ingestion of eggs, usually via food or water contaminated with human feces. Autoinfection may occur if an individual with taeniasis accidentally ingests the eggs of his own tapeworm. After ingestion, the eggs hatch into larvae that can penetrate the intestinal mucosa and migrate throughout the body, typically lodging in the subcutaneous tissues, muscles, eyes, heart, or central nervous system.

The most common clinical presentation of cysticercosis in humans arises from neurologic involvement (neurocysticercosis) and includes headache, seizures, papilledema, focal neurologic deficits, and

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mental status changes. Lesions usually occur in the cerebral parenchyma, subarachnoid space, or ventricles (2). The inflammatory response and symptoms may be exacerbated when the larvae die, often several years after the initial infection.

Cysticercosis occurs throughout the world but is most common in rural areas of developing countries with inadequate sanitary facilities for disposing of fecal waste. *T. solium* infestation is prevalent in 18 South and Central American countries accounting for 94% of the Latin American population (3); in several African countries (4); and in some Asian countries (5). Previously a rare disease in the United States that had been confined to immigrants from endemic zones, cysticercosis has been diagnosed in the U.S. with increasing frequency over the past decade (*6–11*); and while a majority of the cases reported in the literature are still in immigrants, evidence now exists of infection being acquired within the U.S. as well (*6, 9, 10, 12–16*).

The state of California began a program of cysticercosis surveillance in 1989. This statewide program, based on a successful two-year surveillance trial in Los Angeles County (*17*), had two purposes. These were (1) to enable the California Department of Health Services (DHS) to determine the occurrence and demographic distribution of this infection and (2) to identify individuals who acquired their infections within the state so that the source of infection might be pinpointed and preventive measures taken. This article presents an analysis of the data obtained during the first year of statewide surveillance.

METHODS

All cysticercosis cases reported to the DHS by local California health departments between 1 April 1989 and 31 March 1990 were included in the study. Data came partly from mandatory confidential morbidity reports, completed on all identified cases, that indicated the patient's age, race, sex, and county of residence. Further information (on the patient's country of origin, travel history, household contacts, presenting symptoms, and laboratory data) was obtained for Los Angeles County patients from a standard case investigation form routinely employed by the county to investigate cysticercosis cases. In addition, we asked other local health departments that had reported any cysticercosis cases during the 12-month study period to complete a history form for each identified case.

For purposes of the study we defined a case of cysticercosis as a disease case in an individual residing in California who was diagnosed by a physician as having symptoms and laboratory results—serologic, computerized axial tomography (CT) scan, or biopsy results—compatible with a diagnosis of cysticercosis between 1 April 1989 and 31 March 1990.

RESULTS

Patients

One hundred thirty-four cases of cysticercosis were reported to the DHS during the study period. All 112 subjects (84%) for whom case histories were available were diagnosed as having neurocysticercosis. Information on the subjects' country of origin, travel histories, symptoms expressed, and diagnostic tests was obtained from these case histories. Basic demographic information (the subject's age, race, sex, and county) was included, if available, for the 22 subjects with no available case histories.

These sources indicated the gender of 128 subjects, of whom 77 (60%) were males and 51 (40%) were females. The subjects'

ages, known in 129 of the 134 cases, ranged from 20 months to 64 years, the median age being 27 years. Eighty-two percent of the subjects were less than 40 years old.

The subjects' racial/ethnic origins were known in 127 cases. The great majority (117) of the patients were Hispanic, six were Asiatic, three were white non-Hispanic, and one was black. Rates of diagnosed cases indicated by the data for each of these four respective racial/ethnic groups within the state were as follows: 1.5 cases per 100,000 population among Hispanics, 0.2 among Asiatics, 0.05 among blacks, and 0.02 among white non-Hispanics. When the Hispanic population was broken down into ten-year age groups as shown in Figure 1, the highest case rate was found among those 20 to 29 years old (3.3 cases per 100,000).

Country of Origin

Of the 112 subjects whose country of birth or previous residence was stated, 101 (90%) were immigrants (Table 1). Ninety-two of these immigrants (91%) were from Mexico or Central America. Length of residence in the United States, known for 72 of the immigrants, varied from one month to 30 years, the median length of residence being six years.

Travel History

Nineteen of the 101 known immigrants had resided in the United States for 10 years or more before the onset of symptoms; however, only two were known not to have traveled to endemic countries during the previous decade. One, a 47-year-old woman, had immigrated from Mexico 11 years before the onset of symptoms but had frequent visitors from Mexico. The other, a 31-year-old woman, had immigrated from Mexico 12 years before her illness and had no known close contact with recent immigrants.

Travel histories were obtained from nine of the 11 subjects born in the United States. Six of these showed travel to foreign

Figure 1. Cysticercosis cases reported among Hispanic residents of California during the study period (1 April 1989 through 31 March 1990), showing the numbers of cases reported and the numbers of reported cases per 100,000 Hispanic residents statewide, by 10-year age group.

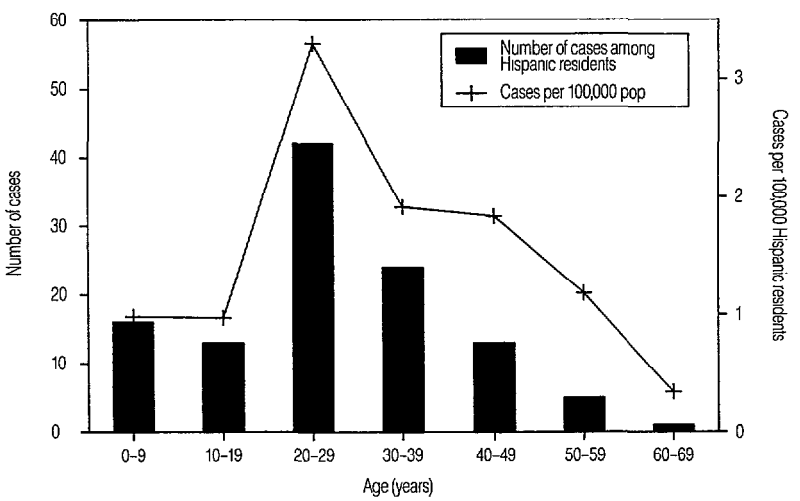

Table 1. Countries of birth of the 134 subjects with reported cysticercosis cases in California, 1 April 1989–31 March 1990.

Country of birth	Cases	
	No.	(%)
Mexico	77	(57)
United States	11	(8)
Guatemala	6	(4)
El Salvador	6	(4)
Korea	3	(2)
Nicaragua	2	(1)
Colombia	2	(1)
Brazil	1	(1)
Chile	1	(1)
Ecuador	1	(1)
Honduras	1	(1)
India	1	(1)
Unknown	22	(16)
Total	134	(100)

countries including Mexico. One individual had frequently traveled to Mexico, while the other five had visited Mexico for periods ranging from one to 30 days, the median period being two days.

We were unable to obtain travel histories from two of the 11 subjects, and three of the remaining nine said they had never traveled outside the United States. However, two of the three had household contact with people from endemic countries. One, a six-year-old Hispanic child, had contact with several family members who had immigrated from El Salvador; the other, a five-year-old white non-Hispanic child, had contact with two live-in housekeepers from El Salvador during his first three years of life. The third subject with no history of foreign travel, a 22-year-old black woman, did not appear to have had close contact with any individuals from endemic areas.

Case Distribution by County

As shown in Figure 2, 20 of California's 58 counties reported at least one case of cysticercosis during the study period. A majority (77) of the 134 patients (57%) resided in Los Angeles County. Orange County reported the second largest number of cases (15), followed by Santa Clara County (9) and San Diego County (7). Nine counties reported only one case.

More than 100,000 Hispanics were residing in Fresno, Kern, Sacramento, and Tulare counties, but no cases were reported by those counties. In contrast, four counties (Colusa, Lake, Placer, and Yuba) each reported a case even though each had fewer than 25,000 Hispanic residents. Overall, while the statewide rate of reported cases among Hispanics, as noted above, was 1.5 cases per 100,000, the number of cases among Hispanics by county ranged from 0 cases per 100,000 to 28 (see Figure 2).

Signs and Symptoms

The presenting signs and symptoms were reported for 112 (84%) of the 134 subjects (Table 2). The most common symptoms were seizure (reported by 71% of the 112) and headache (reported by 61%). Less common signs and symptoms included hydrocephalus, ocular disorders, meningitis, dementia, stroke, and cranial nerve disorders. Eighty-three (74%) of the 112 patients required hospitalization.

Diagnostic Tests

We identified the laboratory tests used to arrive at a diagnosis of cysticercosis for 112 subjects, all of whom had neurocysticercosis (Table 3). Computerized tomography (CT) scans were conducted on over three-quarters (89) of these 112. The most common reported finding was multiple punctate calcifications, followed by areas of low attenuation and ring-enhancing lesions. Serologic tests were performed on 70 subjects. The serologic tests for 50 (71%) of these subjects were

Figure 2. A county-by-county comparison of (A) the numbers of cysticercosis cases reported during the study period (1 April 1989 through 31 March 1990) and (B) the case rates among Hispanic residents (cases per 100,000) in the same period.

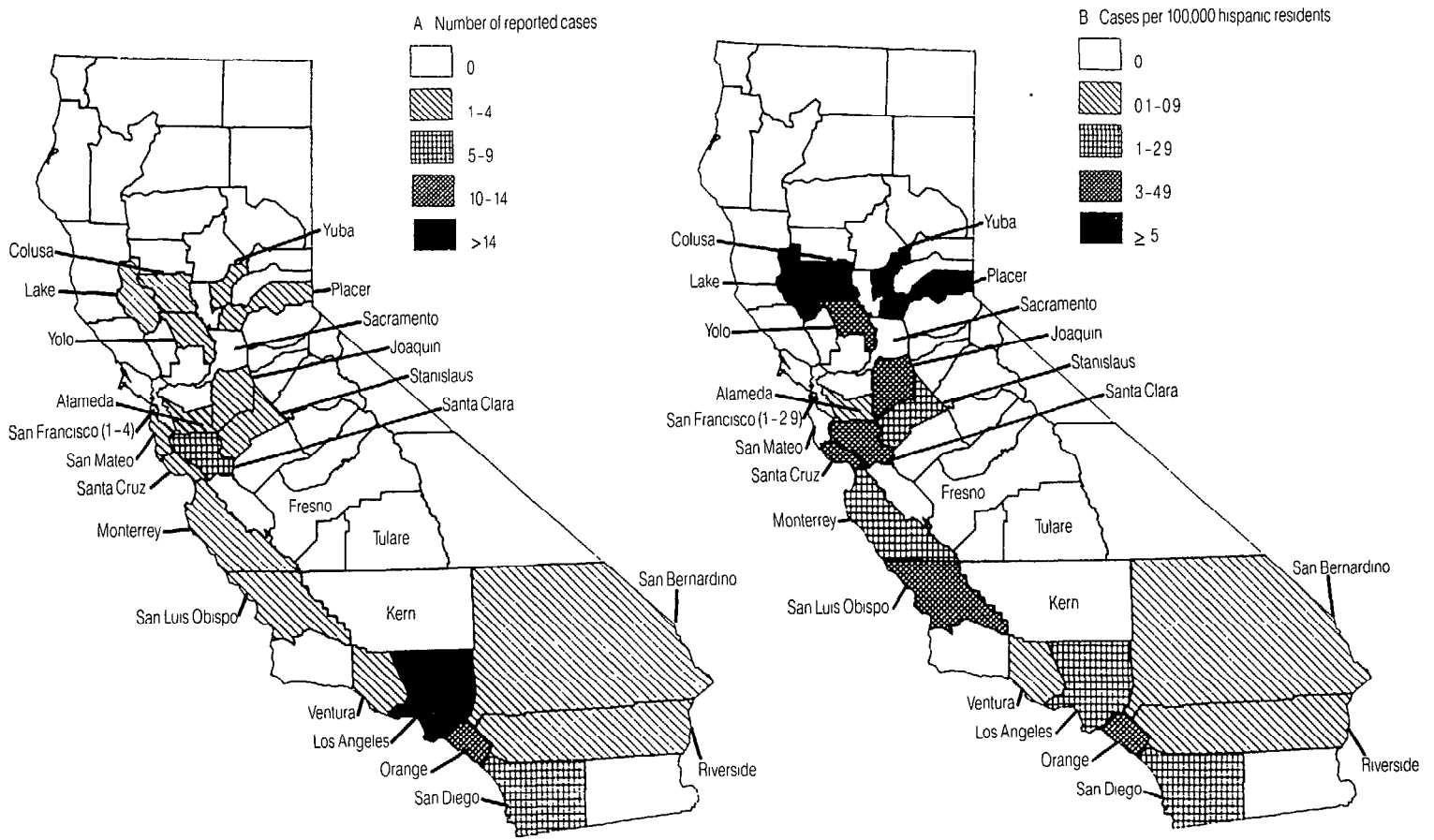

Table 2. Clinical manifestations of the 112 study subjects for whom data on signs and symptoms were available.

Signs and symptoms	Cases (N = 112)	
	No.	(%)
Seizure	80	(71)
Headache	68	(61)
Hydrocephalus	14	(13)
Ocular disorder	11	(10)
Meningitis	9	(8)
Intracranial hypertension	6	(5)
Dementia	6	(5)
Stroke	4	(4)
Generalized weakness	4	(4)
Cranial nerve palsy	3	(3)
Subcutaneous lesion	2	(2)
Muscle pain	1	(1)
Bone lesion	1	(1)

enzyme-linked immunoelectrotransfer blot (immunoblot) assays conducted at the Centers for Disease Control in Atlanta; the serologic tests on the remaining 20 were done at commercial laboratories. In all, 65 of these tests yielded titers positive for cysticercosis, the remaining five being negative. In 16 cases (12% of the subjects) the diagnosis of neurocysticercosis was confirmed by brain biopsy.

Table 3. Laboratory tests performed to arrive at a diagnosis of cysticercosis in the 112 study subjects for whom laboratory data were available.

Diagnostic tests	Cases (N = 112)	
	No.	(%)
Computerized tomography (CT):		
Alone	34	(30)
With serology	44	(39)
With biopsy	5	(4)
With serology and biopsy	6	(5)
Total	89	(79)
Serology:		
Alone	18	(16)
With CT	44	(39)
With biopsy	2	(2)
With CT and biopsy	6	(5)
Total	70	(63)
Biopsy:		
Alone	3	(3)
With CT	5	(4)
With serology	2	(2)
With CT and serology	6	(5)
Total	16	(14)

DISCUSSION AND CONCLUSIONS

Most cysticercosis cases reported during the first year of surveillance in California occurred among immigrants from Latin American countries—primarily Mexico, Guatemala, and El Salvador. Ninety-two percent of the patients whose race and ethnicity were known were of Hispanic origin, a finding that agrees with previously reported clinical data in the United States (*6, 9, 10*). Some of the other individuals identified were probably infected while residing in Asian countries (Korea and India) endemic for *T. solium*.

The available data indicate that the risk of becoming infected in California is fairly small. However, three of the 134 individuals identified were born in the United States and had never traveled to an endemic country. Previous clinical series (*6, 9, 10*) and individual case reports (*12, 13, 15–17*) have identified other individuals who appear to have contracted their infections while in the United States. Data relating to one of the study subjects gave grounds for suspecting that a domestic housekeeper who had immigrated from Latin America was the source of infection, as was apparently true in two previously reported cases (*16, 19*). The literature also reports cases where family members who immigrated from endemic countries (*10, 14*) or visited such countries (*12*) served as a source of infection.

Two of the 134 subjects identified had immigrated from Mexico more than 10 years (one 11 years and the other 12 years) before the onset of symptoms and had not traveled to an endemic country since

immigrating. The two, both women, could have been infected before immigration and then have remained asymptomatic for more than 10 years, or they could have been infected while in the United States.

Individuals can remain asymptomatic until the larvae begin to die, inducing a severe inflammatory response (*20*). It is therefore noteworthy that a previous study identified cases in several immigrants who had not visited endemic areas for a period of over seven years before the onset of symptoms (*10*)—suggesting either that there may occasionally be a prolonged latent period before symptoms appear or that indigenous transmission has been occurring in the United States.

Over half (58%) of the 134 reported cases occurred in Los Angeles County. It should be noted, however, that Los Angeles has a larger population of Hispanic residents than any other California county (*21*). Moreover, the rate of reported cysticercosis among Hispanics residing in Los Angeles County did not differ greatly from the average rate reported among Hispanic residents statewide, being 2.1 cases per 100,000 as compared to 1.5. In this same vein, while the statewide distribution of reported cases did not perfectly mirror the county-by-county distribution of Hispanic residents, a trend in that direction was evident. For instance, three-quarters of the 16 counties with over 100,000 Hispanic residents reported at least one case of cysticercosis, while only 19% of the counties with fewer than 100,000 Hispanic residents reported any cases.

Three counties (Lake, Colusa, and Yuba) reported well over five cases per 100,000 among Hispanic residents. However, since each county reported only one case, it was the relatively small size of their Hispanic populations (3,633 in Lake, 5,424 in Colusa, and 6,728 in Yuba) that produced the illusion of very high apparent rates (27.5, 18.4, and 14.9 cases per 100,000 Hispanics, respectively, in the three counties).

The two most common presenting symptoms of cysticercosis in those patients with available histories were seizure and headache. A previous report on 23 cases of cerebral cysticercosis diagnosed in a San Diego hospital found symptoms associated with cranial pressure (headache, nausea, vomiting) to be the most common (*7*). Previous reviews of hospital records have found a smaller proportion of patients with seizures (30–56%) (*6–8, 10, 11*).

CT scans, serologic tests, magnetic resonance imaging, and biopsies can all aid the physician in reaching a diagnosis of cysticercosis. Previously, serodiagnostic tests for cysticercosis were only 80% to 95% sensitive and specific (*22*); however, the aforementioned immunoblot assay that was developed recently is highly (98%) sensitive and extremely (100%) specific (*23*). This immunoblot assay was used to verify the diagnosis in 50 of the patients in this study.

The most useful diagnostic test for neurocysticercosis is a CT scan of the head (*10*). This commonly shows space-occupying lesions, hydrocephalus, or scattered cerebral calcifications. In this study, a diagnosis of neurocysticercosis was verified by a CT scan of the head in 79% of the subjects whose histories were available.

In conclusion, while 97 of the 134 individuals diagnosed with cysticercosis in California had immigrated from Latin American countries, it is possible for infection to be locally acquired in the United States. It also seems clear that cysticercosis should be included in the differential diagnosis of neurologic symptoms (seizure, headache, hydrocephalus) in patients who have immigrated from or visited *T. solium*-endemic countries, as well as in patients who have had household contact with immigrants from endemic countries.

With respect to preventive measures, when a case of cysticercosis is documented, family members should be educated about the epidemiology of the disease and the need for proper procedures and sanitary feces disposal. In addition, the patient, the family, and other household members should be examined for the presence of *T. solium* and treated accordingly, as individuals excreting eggs are a potential source of transmission, both to others and to themselves by autoinfection.

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