RETROSPECTIVE SEROSURVEY OF LEPTOSPIROSIS AMONG PATIENTS WITH ACUTE FEBRILE ILLNESS AND HEPATITIS IN EGYPT

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Abstract. The epidemiologic status of leptospirosis in Egypt has not been well defined because of difficulties in disease diagnosis. A retrospective study was conducted to detect leptospiral antibodies among undiagnosed acute febrile illness (AFI) and hepatitis cases. Approximately 16% of both AFI (141/886) and acute hepatitis (63/392) cases showed seroreactivity to Leptospira IgM by ELISA and microscopic agglutination test (MAT). Canicola, Djasima, Grippotyphosa, Pyrogenes, Icterohaemorrhagiae, and Pomona were the most commonly reactive serovars among patients with AFI. Djasiman, Grippotyphosa and Icterohaemorrhagiae were the most reactive among patients with acute hepatitis. This study represents the first systematic report of Leptospira associated with patients with AFI and hepatitis in Egypt. Physicians need to have increased awareness about the importance of leptospirosis in the differential diagnosis of AFI and acute hepatitis in Egypt. In addition, laboratory capacity should be developed at fever hospitals to diagnose leptospirosis.

INTRODUCTION

Leptospirosis is a worldwide public health problem. The majority of infections are observed in tropical and subtropical regions caused by contact with Leptospira-contaminated environments during agricultural or recreational practices or when waste disposal systems are ineffective.1,2 Leptospirosis is a potentially serious but treatable disease. Its symptoms may mimic those of a number of other unrelated infections such as influenza, meningitis, hepatitis, dengue, malaria, or viral hemorrhagic fevers. Leptospirosis has recently caused large outbreaks where the diagnosis was often initially overlooked.3 For this reason, it is important to distinguish leptospirosis from dengue and viral hemorrhagic fevers, among others, in patients acquiring infections in countries where these diseases are endemic.3

The disease is considered an occupational hazard for agricultural and dairy farmers, sewer workers, veterinarians, fishing industry workers, and military personnel. It is also recognized as a recreational hazard among campers and athletes exposed to waters contaminated with Leptospira. Nevertheless, available data on the incidence and prevalence of leptospirosis in the Middle East are scarce.5–9 In Egypt, pilot studies have revealed that 9% of sera collected from persons living in contact with carrier animals are reactive to different Leptospira serogroups.8 In addition, animal serosurvey studies have shown that a considerable proportion of swine (55%), rodents (14%), canine, and equine animals are seropositive for L.icterohaemorrhagiae and other Leptospira serogroups.7 Because the clinical presentation of leptospirosis is non-specific, however, laboratory-confirmed data are needed to determine the incidence of disease and associated risk factors before establishing appropriate disease prevention strategies. We have conducted laboratory-based surveillance for AFI in Egypt since 1999 and found that ~30% of the cases were explained by typhoid and brucellosis (≥ 70% of the cases had unknown etiology).8 Similarly, surveillance for acute hepatitis in Egypt revealed that about one third of all cases remain unexplained. The objective of this study was to use IgM ELISA and the microscopic agglutination test (MAT) to determine the proportion of Leptospira-reactive antibodies in acute febrile illness (AFI) and acute hepatitis cases identified from multiple sentinel surveillance sites in Egypt.

MATERIALS AND METHODS

In 1999, the US Naval Medical Research Unit 3 (NAMRU-3) and the Egyptian Ministry of Health and Population implemented laboratory-based surveillance in a network of 14 infectious disease hospitals (also referred to as fever hospitals) throughout Egypt for defining the causes of AFI and hepatitis. Only six fever hospitals remained in the network for the entire 4-year study period (1999–2003), representing six different governorates: Abbassia fever hospital (Cairo), which also serves as a national reference center; Alexandria fever hospital (Alexandria), Mediterranean coast; Assuit fever hospital (Assuit) in the agricultural upper Egypt area; Mahalla fever hospital (Gharbiya), lower Egypt; Imbaba fever hospital (Giza), upper Egypt; and Qena fever hospital (Qena), upper Egypt. For all enrolled subjects, data regarding basic demographic and clinical characteristics were collected. Informed consent was obtained from all participating subjects.

Case definitions. A case of AFI was defined as any individual with a history of fever (temperature ≥ 38°C) for 3 days or more. Exclusion criteria included the presence of obvious clinical signs for certain diseases such as diarrhea, pneumonia, typhoid fever, brucellosis, or established fever of unknown origin (FUO). A case of acute hepatitis was defined as any individual presenting with signs and symptoms of acute jaundice.

AFI samples. Blood samples were collected from informed consenting subjects who met the AFI case definition at the time of admission (acute). A second sample (convalescent) was collected whenever possible 1–3 weeks after the acute sample or on discharge from the hospital. An aliquot of the sera was stored in cryovial tubes and preserved in liquid ni-
trogen tanks until shipped to NAMRU-3. Routine work at the surveillance sites included blood cultures and serologic testing for typhoid (Widal tube test) and brucellosis (Brucella agglutination tube test); positive results were confirmed at NAMRU-3. A subsequent study later assessed the presence of anti-rickettsial antibodies by ELISA (unpublished data). For the purpose of this study, we tested 1,772 paired serum specimens (886 cases), all of which tested negative for Salmonella enterica serovar Typhi, Brucella spp., and Rickettsia spp.

**Hepatitis samples.** A total of 392 single acute sera from patients who met the case definition were included; all of which tested negative for viral hepatitis A, B, and C (ELISA; Murex Biotech, Dartford, UK).

**ELISA.** The Leptospira IgM ELISA (PanBio, Brisbane, Australia) was used as a screening test for the diagnosis of acute leptospirosis. We used a value of 1.1 as the cut-off value for further testing by MAT. The ELISA detects genus-specific antibodies and is not suitable for serogroup/serovar identification.9,10

**Microscopic agglutination test.** The standard MAT was performed on ELISA-positive sera to determine the most reactive Leptospira serogroups.9,11,12 In addition, 10% of the ELISA-negative sera were also screened by MAT. Briefly, live Leptospira cell suspensions representing 20 serovars were added to serially diluted serum specimens in a 96-well microtiter plates and incubated at ambient temperature for 1.5 hours. Agglutination was examined by dark-field microscopy at a magnification of ×100. A reactive MAT was determined by titers ≥ 1:200.3 The reported titers were calculated as the reciprocal of highest serum dilutions that agglutinated at least 50% of the cells for each serovar used. Serovars included in the antigen panel were L. interrogans serovar Australis (serogroup Australis, strain Ballico), L. interrogans serovar Bratislava (serogroup Australis, strain Jez Bratislava), L. interrogans serovar Autumnalis (serogroup Autumnalis, strain Akiyami A), L. borgpetersenii serovar Ballum (serogroup Ballum, strain Mus 127), L. interrogans serovar Bataviae (serogroup Bataviae, strain Van Tienen), L. interrogans serovar Canicola (serogroup Canicola, strain Ruebush), L. kirschneri serovar Cynopteri (serogroup Cynopteri, strain 3522 C), L. interrogans serovar Grippotyphosa (serogroup Grippotyphosa, strain HS616), L. borgpetersenii serovar Tarassovi (serogroup Tarassovi, strain Perepelycin), L. interrogans serovar Wolfii (serogroup Sejroe, strain 3705), L. weilii serovar Celledoni (serogroup Celledoni, strain Celledoni), L. interrogans serovar Djasiman (serogroup Djasiman, strain Djasiman), L. borgpetersenii serovar Javanica (serogroup Javanica, strain Veldrat Batavia 46), and L. santarosai serovar Borincana (serogroup Borincana, strain HS622). Cultures of all Leptospira serovars required for MAT testing were provided by Dr Bajani (CDC, Atlanta, GA). MATs are not adequate for determining the infecting Leptospira serovar but can allude to serogroup.

**RESULTS**

**AFI cases.** Of 886 patients with paired sera, 141 (16%) were positive for Leptospira by ELISA and MAT (titer ranges, 1/200–1/12,800; Table 1). Seroconversion with ≥ 4-fold increase in MAT titer was observed among all (100%) acute and convalescent paired samples. The highest number of reactive cases by MAT (titer ≥ 1:200) was 29% and 12% using serovars Canicola and Djasiman, respectively. The proportion of Leptospira-reactive patients as a group

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**TABLE 1**

Distribution and seroconversion of patients with AFI in different governorates in Egypt

<table>
<thead>
<tr>
<th>Leptospira serovar</th>
<th>No. (%)</th>
<th>ABS* FH</th>
<th>ALX* FH</th>
<th>AST* FH</th>
<th>MAL* FH</th>
<th>IMB* FH</th>
<th>QEN* FH</th>
<th>Acute titer</th>
<th>Convalescent titer</th>
<th>Occupation†‡</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canicola</td>
<td>41 (29)</td>
<td>19</td>
<td>11</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>0–400</td>
<td>200–12,800</td>
<td>S, L, O</td>
</tr>
<tr>
<td>Djasiman</td>
<td>17 (12)</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>0–400</td>
<td>200–1,600</td>
<td>S, L, F, O</td>
</tr>
<tr>
<td>Grippotyphosa</td>
<td>11 (7.8)</td>
<td>5</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0–400</td>
<td>400–6,400</td>
<td>S, F, O</td>
</tr>
<tr>
<td>Pyrogenes</td>
<td>11 (7.8)</td>
<td>4</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>0–400</td>
<td>400–3,200</td>
<td>S, F, L O</td>
</tr>
<tr>
<td>Icterohaemorrhagiae</td>
<td>9 (6.4)</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0–400</td>
<td>400–3,200</td>
<td>S, L, O</td>
</tr>
<tr>
<td>Pomona</td>
<td>9 (6.4)</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0–200</td>
<td>200–3,200</td>
<td>S, L, O</td>
</tr>
<tr>
<td>Javanica</td>
<td>5 (3.6)</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0–400</td>
<td>400–1,600</td>
<td>S, O</td>
</tr>
<tr>
<td>Wolfii</td>
<td>4 (2.8)</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0–400</td>
<td>400–800</td>
<td>S, O</td>
</tr>
<tr>
<td>Ballum</td>
<td>4 (2.8)</td>
<td>3</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0–200</td>
<td>400–1,600</td>
<td>S, L, O</td>
</tr>
<tr>
<td>Borincana</td>
<td>4 (2.8)</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0–200</td>
<td>300–800</td>
<td>S, L, O</td>
</tr>
<tr>
<td>Celledoni</td>
<td>4 (2.8)</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0–400</td>
<td>400–3,200</td>
<td>L, O</td>
</tr>
<tr>
<td>Mankarso</td>
<td>4 (2.8)</td>
<td>3</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0–200</td>
<td>400–800</td>
<td>L, O</td>
</tr>
<tr>
<td>Tarassovi</td>
<td>4 (2.8)</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0–400</td>
<td>400–1,600</td>
<td>S, O</td>
</tr>
<tr>
<td>Australis</td>
<td>3 (2)</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0–400</td>
<td>400–800</td>
<td>L, F, O</td>
</tr>
<tr>
<td>Autumnalis</td>
<td>3 (2)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0–400</td>
<td>400–1,600</td>
<td>S, L, O</td>
</tr>
<tr>
<td>Georgia</td>
<td>3 (2)</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0–400</td>
<td>400–1,600</td>
<td>S</td>
</tr>
<tr>
<td>Batvica</td>
<td>3 (2)</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0–800</td>
<td>800</td>
<td>L, O</td>
</tr>
<tr>
<td>Alexi</td>
<td>1 (0.07)</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>400–1,600</td>
<td></td>
<td>S</td>
</tr>
<tr>
<td>Bratislava</td>
<td>1 (0.07%)</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0–1,600</td>
<td>1,600</td>
<td>S</td>
</tr>
</tbody>
</table>

| Total             | 141/886| 68/357  | 33/315  | 16/29   | 15/63   | 8/55    | 1/67    | 0–400      | 200–12,800       | S             |

* ABS FH, Abbassia Fever Hospital; ALX, Alexandria; AST, Assuit; MAL, Mahalla (Osharbiya); IMB, Imbaba (Giza); QEN, Qena.
† S, student; L, laborer; F, farmer; O, other (driver, office employee, health worker, butcher, undetermined, etc.).
‡ Student (6–21 years, mean, 13.2 years) showed the highest incidence of leptospirosis among the AFI cases (n = 48, 34%). Laborers (16–44 years; mean, 31.2 years) were the second highest group (n = 18, 13%), whereas other groups represented 53% (n = 75/141).
among all AFI cases tested was considerably higher in Assuit (55%), Mahalla (24%), and Abbassia (19%) fever hospitals compared with other participating hospitals (Table 1).

Patients with AFI reactive for *Leptospira* antibodies had a median age of 25 years, and 53% were women (Table 2). Persons of school age (6–21 years) had the highest proportion of reactive cases (34%), followed by laborers (13%) and farmers (7%). Sera from school-age persons (median age, 13 years) were mainly reactive with serovars Canicola (18/48, 37.5%), Djasiman (5/48, 10%), and Grippotyphosa (5/48, 10%), whereas laborers showed higher reactivity with Icterohemorrhagiae (4/18, 22%). AFI subjects were exposed to chickens (19%), ducks (14.5%), slaughtered animals (13.5%), and buffaloes (12%). Information on exposure to waterways was not available.

**Hepatitis cases.** Of 392 sera from non-A, -B, or -C hepatitis cases, 63 (16%) were reactive to *Leptospira* by ELISA and MAT (titer range of 1/200–1/25,600; Table 3). The highest number of reactive cases by MAT was 20% using serovars Djasiman and Grippotyphosa and 16% using serovar Icterohemorrhagiae. Of the *Leptospira*-positive cases, 32/63 (51%) were men (Table 2). Laborers and drivers represented 16% and 8%, respectively, whereas farmers, police, soldiers, office employees, and students each showed < 5% of *Leptospira*-reactive cases.

The distribution of *Leptospira*-reactive cases among suspected patients with hepatitis was 24%, 19%, and 10.4% for Mahalla (Ghariya), Cairo, and Alexandria governorates, respectively. The proportion of leptospiral infections among AFI and acute hepatitis cases peaked in the summer and fall months. The monthly rate (%) of leptospiral infections throughout the year is represented in Figure 1.

**DISCUSSION**

This study represents the first systematic serosurvey documenting the occurrence of acute human leptospirosis in Egypt. It also described the prevalent serovars and clinical presentation, which are important for disease management and prevention. Although MATs are not reliable in determining specific *Leptospira* serovars in a region, the serogroups detected in this study are relatively similar to the early reports of animal infections and human exposures in Egypt. Testing of animals at two waste disposal sites in Egypt showed that 55.4% and 14.3% of rats and swine were seropositive for serogroup Icterohaemorrhagiae, respectively. Early reports from Egypt had also shown 8.7% of sera collected from human living in these areas were reactive to different serogroups. Also, canine and equine sera were highly reactive to different *Leptospira* serogroups. Previous studies showed that Bratislava was among the most common serovars in humans, followed by Icterohaemorrhagiae and Grippotyphosa. Other studies on rodents, pigs, donkeys, goats, and sheep revealed that Icterohaemorrhagiae, Pomona, Australis, and Canicola were among the encountered serovars from animal samples. These reports support the presence of high transmission risks for leptospirosis in the Nile valley. It is of epidemiologic importance to determine the serovar because they may develop a commensal or comparatively mild pathogenic relationship with a certain animal host species. Broadly speaking, each leptospiral serovar tends to be associated with a particular species of natural maintenance host.

Very limited data exist on the burden of human leptospiral infections in Egypt. In this study, Alexandria, Cairo, and Gharbiya showed the highest prevalence of leptospiral infections among hepatitis cases in Egypt. These findings are overall consistent with previous serosurvey studies on domestic and wild animal in Egypt. Twenty serovars of the genus representing 17 serogroups were used in this study. Eight of these have previously been reported as the most virulent in causing animal disease in this area. Clinical misdiagnosis and absence of earlier clinical recognition may have contributed to the lack of reports and may also have masked the true state of disease endemicity.

In the Middle East, some countries around Egypt have reported endemic leptospirosis. In Israel, Weil disease, caused by serogroup Icterohaemorrhagiae, has been recognized for several decades and is considered endemic. In 2003, leptospirosis caused severe illness among children in Eastern Turkey, emphasizing the importance of leptospiro-

### Table 2

Demographic, epidemiologic, and clinical characteristics of patients with AFI and hepatitis with leptospirosis

<table>
<thead>
<tr>
<th>Criteria</th>
<th>AFI cases</th>
<th>No. (%)</th>
<th>Hepatitis cases</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>75/141</td>
<td>(53)</td>
<td>Male</td>
<td>32/63</td>
</tr>
<tr>
<td>Female</td>
<td>66/141</td>
<td>(47)</td>
<td>Female</td>
<td>31/63</td>
</tr>
<tr>
<td><strong>Occupation and age distribution (yr)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student (6–21; mean, 13.2)</td>
<td>48 (34)</td>
<td></td>
<td>Laborer (2–65; mean, 35)</td>
<td>10 (16)</td>
</tr>
<tr>
<td>Laborer (16–44; mean, 31.2)</td>
<td>18 (13)</td>
<td></td>
<td>Driver (29–47; mean, 38)</td>
<td>5 (8)</td>
</tr>
<tr>
<td>Farmer (16–57; mean, 32)</td>
<td>10 (7)</td>
<td></td>
<td>Other (20–65; mean, 39)</td>
<td>11 (18)</td>
</tr>
<tr>
<td>Office (20–48; mean, 31)</td>
<td>7 (5)</td>
<td></td>
<td>None (22–73; mean, 40)</td>
<td>33 (52)</td>
</tr>
<tr>
<td>Driver (32–39; mean, 35)</td>
<td>3 (2)</td>
<td></td>
<td>Other &gt; 5%</td>
<td></td>
</tr>
<tr>
<td>Other (17–55; mean 30.6)</td>
<td>14 (10)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unknown (3–57; mean, 26.5)</td>
<td>41 (29)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Disease symptoms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fever duration (average)</td>
<td>13 days</td>
<td></td>
<td>Acute jaundice</td>
<td>63 (100)</td>
</tr>
<tr>
<td>Admission temperature: ≥ 38°C</td>
<td>125 (89)</td>
<td></td>
<td>Dark urine</td>
<td>63 (100)</td>
</tr>
<tr>
<td>Headache</td>
<td>115 (82)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vomiting</td>
<td>72 (51)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Undulant fever</td>
<td>63 (44)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arthralgia</td>
<td>53 (38)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myalgia</td>
<td>47 (33)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pharyngitis</td>
<td>37 (26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual rash</td>
<td>11 (8)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jaundice</td>
<td>6 (4)</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
sis in rural areas where farming is the major source of income. In Jordan, studies have shown that 49.7% of the cattle were seropositive for several serogroups. Afzal and Sakkir claimed that 4.1% of a racing camel population in the Arabian Peninsula had antibodies for *L. interrogans* species. In Sudan, 54% and 9.8% of ruminants and wild animals were highly positive for a diversity of serovars.

Definitive laboratory diagnosis of leptospirosis requires detection of the organism in a clinical specimen or a 4-fold or greater increase in MAT titer in the setting of an appropriate clinical syndrome. In our study, seroconversion from 0 to 1/200 was considered positive because endemicity of leptospirosis has not previously been reported in Egypt. The relatively high percentage of leptospiral infections in this study, among AFI and hepatitis cases, signifies that Egypt is endemic with leptospirosis. As per the WHO definition, we expect that future reports from Egypt may consider positive cases having a MAT titer of 1/800 or higher. The AFI and hepatitis surveillance studies were not designed to look specifically at the incidence of leptospirosis and its associated exposures. However, the high proportion of unexplained AFI and hepatitis cases was the impetus for examining other causes of these clinical symptoms. In Egypt, exposures to waterways and animals, which have traditionally been associated with leptospirosis, are very common, especially in rural areas. Kobayashi indicated that leptospirosis can occur in individuals of all ages, any time of the year, and in both sexes. The demographic characteristics of acute leptospirosis cases in our study suggest that exposures occurred mostly in early ages and could indicate that adults in rural areas, because of acquired long-term immunity to specific serovars, had milder illness with leptospiral infection. It also showed that students of school ages, laborers, and farmers represented the highest-risk groups among other professions.

In Egypt, most patients with AFI are empirically diagnosed with typhoid and treated accordingly with ampicillin or tetracycline. Because patients with leptospirosis present with similar AFI signs and symptoms and would respond to these antibiotics, leptospirosis is almost never diagnosed in Egypt and has therefore not been recognized as an important public health problem. Also, the majority, if not all, of patients with hepatitis are only diagnosed as having viral hepatitis A, B, or C. Therefore, this study highlights the importance of leptospirosis as a cause of AFI and hepatitis in Egypt and supports the need for future prospective studies to assess specific risk factors associated with leptospirosis. Such studies will be crucial for the design of prevention strategies, which is possible by instituting rodent control measures and avoiding contaminated water and soil.

The diagnosis of leptospirosis should be considered in any patient presenting with an abrupt onset of fever, chills, conjunctival suffusion, headache, myalgia, and jaundice. Suspicion is further increased if there is a history of occupational or recreational exposure to infected animals or to an environment potentially contaminated with animal urine. Once the possibility of leptospirosis has been considered, appropriate diagnostic tests and clinical management should be instituted. Furthermore, it is important to increase awareness about leptospirosis among physicians in Egypt and to strengthen laboratory capacity for its diagnosis in infectious hospitals.

### Table 3

<table>
<thead>
<tr>
<th>Leptospira serovar</th>
<th>No. positive (%)</th>
<th>MAT titers*</th>
<th>ABS FH</th>
<th>ALX FH</th>
<th>MAL FH</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canicola</td>
<td>6 (10)</td>
<td>200–800</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>O</td>
</tr>
<tr>
<td>Djasiman</td>
<td>13 (20)</td>
<td>200–800</td>
<td>6</td>
<td>7</td>
<td>0</td>
<td>O</td>
</tr>
<tr>
<td>Grippotyphosa</td>
<td>13 (20)</td>
<td>200–25,600</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>L, O</td>
</tr>
<tr>
<td>Pyrogenes</td>
<td>9 (14)</td>
<td>200–800</td>
<td>4</td>
<td>6</td>
<td>0</td>
<td>L, O</td>
</tr>
<tr>
<td>Interohemorrhagiae</td>
<td>10 (16)</td>
<td>200–25,600</td>
<td>5</td>
<td>5</td>
<td>0</td>
<td>L, O</td>
</tr>
<tr>
<td>Pomona</td>
<td>2 (3)</td>
<td>200–400</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>O</td>
</tr>
<tr>
<td>Wolfii</td>
<td>3 (5)</td>
<td>200</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>O</td>
</tr>
<tr>
<td>Bratislava</td>
<td>7 (11)</td>
<td>200–800</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>S, L, O</td>
</tr>
<tr>
<td>Total</td>
<td>63/392 (16)</td>
<td>200–25,600</td>
<td>25/162</td>
<td>35/168</td>
<td>4/62</td>
<td>(15%)</td>
</tr>
</tbody>
</table>

* MAT titers: acute sera only.
† ABS, Abbassia Fever Hospital (Cairo); ALX, Alexandria; MAL, Mahalla (Gharbeya).
‡ S, student; L, laborer; F, farmer; O, other (driver, office employee, health worker, butcher, undetermined, etc.).

**Figure 1.** Rate of leptospiral infection throughout the year.
large, the Department of Defense, the Department of the Army, or
the Egyptian Ministry of Health and Population. The study protocol
was approved by the US Naval Medical Research Unit No.3 Institu-
tional Review Board (Protocol NAMRU3.1999.0001 [DoD 30969]) in
compliance with all Federal regulations governing the protection of
human subjects.

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