Epidemiology of Cutaneous Leishmaniasis in Suriname: A Study Performed in 2006

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INTRODUCTION

Leishmaniasis is a vector-borne disease caused by the obligate intracellular protozoan Leishmania parasites of vertebrate hosts, including humans. The disease is prevalent throughout the world in 88 countries, with an overall prevalence of 12 million people, causing a burden estimated at 1,249,000 disability adjusted life years (DALY) for men and 840,000 for women.1 In Suriname, an endemic country in the northern part of South America, cutaneous leishmaniasis (CL) is widespread in the primary rain forest and mainly affects people during the rainy seasons. It was described in 1911 and is locally known as Boschyaws or Boesjiev-Yassi.2

The last estimations of the annual incidence of CL in Suriname were made between 1979 and 1985: 4.9 cases per 1,000 inhabitants for the forested hinterland and 0.66 per 1,000 inhabitants for the whole country.1 The sandfly Phlebotomus anduzei was described as a vector,2 currently believed to be Lutzomyia umbratilis.3 The two-toed sloth (Choloepus didactylus), the anteater (Tamanduua tetradactyla), and several species of marsupials and rodents are assumed to be reservoirs of Leishmania in Suriname.2 Therefore, two PCR-RFLP methods were performed on skin biopsies of CL suspected patients who were prospectively included in Paramaribo.2,13

A second objective of this study was to estimate the annual detection rate of CL in Suriname in 2006. Vector-borne diseases such as leishmaniasis are thought to (re-)emerge in some areas because of environmental changes.15 In Suriname, deforestation and gold mining activities in the forested hinterland are increasing, and there is considerable high migration, mainly of gold miners from Brazil. CL is not a notifiable disease in Suriname; therefore, no up-to-date data are available on prevalence or incidence of this disease. To meet the second objective, medical records were retrospectively reviewed at the dermatology clinics in Paramaribo, questionnaires were distributed to 55 medical posts in the forested hinterland, and 7 of these medical posts were visited.

MATERIALS AND METHODS

The study. This study was reviewed and approved by the Medical Ethical Committee of the Academic Medical Center (AMC) in Amsterdam (MEC 03/228) and by the Ministry of Health in Paramaribo (VG 2006-001). One part of the study was performed in 2006 in Paramaribo, 152 patients were registered, of whom 33 were tested in two polymerase chain reaction (PCR)-restriction fragment length polymorphism (RFLP) methods. Twenty-seven patients were infected with L. (V.) guyanensis (complex), one with L. (V.) lainsoni, and one with L. (Leishmania) amazonensis. In the hinterland, 162 CL suspected patients were registered by questionnaires; of these, 24 of 27 tested positive by PCR-RFLP (88.9%; 95% CI, 77.1–100%). With extrapolation of collected data, a detection rate was calculated of 5.32 to 6.13 CL patients per 1,000 inhabitants for the hinterland and 0.64 to 0.74 patients per 1,000 inhabitants for the whole country.
was conducted at the dermatology clinics (Dermatology Service of Ministry of Health and Dermatology Department, Academic Hospital) in the capital of Suriname, Paramaribo, and the second part in the hinterland of the country in collaboration with the Medical Mission (MZ, Primary Health Care Suriname, Paramaribo, Suriname).

**Paramaribo.** CL suspected patients were included prospectively at the dermatology clinics in Paramaribo from January to March and June to August 2006. Patients were included when informed consent was obtained, and lesions were not confined to the face. They were interviewed and examined, and 2-mm skin biopsies were collected from the indurated border of the lesion. Patients were defined as CL positive when skin smear and/or PCR (hsp70 or mini-exon) were positive. Additionally, a retrospective study was performed on medical records to detect the number of CL patients (who were not included in the prospective study) who visited the dermatology clinics in Paramaribo in 2006.

**Hinterland.** Questionnaires were distributed to all 55 medical posts in the forested hinterland, and health workers registered suspected cutaneous leishmaniasis patients from January until the end of December 2006. The questionnaire included questions regarding age, sex, profession, ethnic group, (estimated) date of infection, start of symptoms, number and location of lesions, and presence of lymphangitis. Health workers were asked to fill in a questionnaire for every new patient diagnosed (only based on clinical criteria) with CL and to return these forms to the head office in Paramaribo.

To validate this method, seven medical posts in the forested hinterland in different parts of Suriname were visited from February to April 2006. Questionnaires were reviewed, and current CL suspected patients were physically examined. Biopsies were collected from the indurated border of the CL suspected lesion.

**Parasite characterization.** Skin biopsies were stored in L6 lysis buffer (50 mmol/L Tris HCl, 5 mol/L GuSCN, 20 mmol/L EDTA, 0.1% Triton-X-100) at −70°C at the Central Laboratory (Paramaribo, Suriname). After transport to KIT Biomedical Research (Amsterdam, The Netherlands), the samples were processed as described by van der Meide and others. Nucleic acid extractions of the patient samples were processed as described by van der Meide and others (Amsterdam, The Netherlands), the General Bureau of Statistics and Medical Mission, Paramaribo, Suriname). After transport to KIT Biomedical Research (Paramaribo, Suriname). After transport to KIT Biomedical Research (Amsterdam, The Netherlands), the samples were processed as described by van der Meide and others. Nucleic acid extractions of the patient samples were analyzed in two PCR-RFLP methods: one assay was based on the spliced leader RNA gene (mini-exon) and the other on the hsp70 gene, as described by Marfurt and others and Garcia and others. In each PCR run, the following reference strains were included as positive controls: *Leishmania (V.) guyanensis* MHOM/BR/75/M4147, *L. (V.) braziliensis* MHOM/BZ/75/M2903, *L. (Leishmania) mexicana* MHOM/MX/85/Solis, *L. (L.) amazonensis* MHOM/BR/81/LTB16, *L. (V.) lainsoni* MHOM/BR/86/M6426, and *L. (V.) naiffi* MHOM/00/94/CRES58.

**Calculations.** The proportion (upper and lower limit) of PCR-positive patients in the study population in the forested hinterland was calculated by a 95% CI (1.96 × SE). To estimate the detection rate of CL patients in Suriname, the estimated number of CL patients (lower and upper limit) were divided by the number of inhabitants for the whole country (487,024) and forested hinterland (59,034; numbers provided by the General Bureau of Statistics and Medical Mission, Paramaribo).

**RESULTS**

**Paramaribo.** Thirty-four CL suspected patients were included in the prospective study in Paramaribo. Thirty-three patients were defined as CL patients (based on microscopy and/or PCR), whereas one patient tested negative and was excluded. Twenty-seven of the 33 CL patients were positive in both mini-exon and hsp70 PCR; 25 patient samples were identified as *L. (V.) guyanensis*, 1 sample as *L. (V.) lainsoni*, and 1 sample as *L. (L.) amazonensis*. Two patient samples were identified as *L. (V.) guyanensis* in mini-exon PCR-RFLP but were negative in hsp70 PCR. Because *L. (V.) guyanensis* has the same fragment pattern as *L. (V.) lainsoni* in mini-exon PCR-RFLP, *L. (V.) lainsoni* cannot be excluded as a causative agent in these cases. Four patients were positive by microscopy but negative with PCR. Geographical distribution and infecting *Leishmania* species of the 29 CL confirmed patients are presented in Table 2.

Additionally, 111 medical records of CL patients were filed at the Dermatology Service, whereas 8 records were filed at the Academic Hospital in 2006. These patients were not included in the prospective study. Added together, 152 CL patients were registered at the dermatology clinics in Paramaribo. All patients were confirmed CL positive with microscopy, histopathology, and/or PCR. The median age was 30 years (range, 2–71 years), most patients were male (N = 124, 81.6%) and Maroons (N = 96, 63.2%), and they lived and/or worked in the forested hinterland. In Figure 1A the age distribution of the patients is given by sex.

**Hinterland.** In total, 162 questionnaires of CL suspected (CLS) patients, 99 (61%) male and 63 (39%) female, were included in the prospective study. Thirty-three CL patients were defined as CL patients (based on microscopy and/or PCR), whereas one patient tested negative and was excluded. Twenty-seven of the 33 CL patients were positive in both mini-exon and hsp70 PCR; 25 patient samples were identified as *L. (V.) guyanensis*, 1 sample as *L. (V.) lainsoni*, and 1 sample as *L. (L.) amazonensis*. Two patient samples were identified as *L. (V.) guyanensis* in mini-exon PCR-RFLP but were negative in hsp70 PCR. Because *L. (V.) guyanensis* has the same fragment pattern as *L. (V.) lainsoni* in mini-exon PCR-RFLP, *L. (V.) lainsoni* cannot be excluded as a causative agent in these cases. Four patients were positive by microscopy but negative with PCR. Geographical distribution and infecting *Leishmania* species of the 29 CL confirmed patients are presented in Table 2.

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**Table 1**

<table>
<thead>
<tr>
<th>Patient characteristics</th>
<th>Age (median year, range)</th>
<th>Unknown</th>
<th>Sex (number males, %)</th>
<th>Lesions (median number, range)</th>
<th>Location lesions (no. patients, %)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>24 (3–81)</td>
<td>7 (4%)</td>
<td>99 (61%)</td>
<td>1 (1 to &gt; 10)</td>
<td>Legs (110% (67%))</td>
</tr>
<tr>
<td>Ethnic group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Maroons (151 (93%))</td>
</tr>
<tr>
<td>Profession</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Gold miners (42 (26%))</td>
</tr>
<tr>
<td>Presence lymphangitis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes (77 (48%))</td>
</tr>
</tbody>
</table>

* Totals are > 100% because some patients had lesions on different parts of the body.
returned to the coordination center of the Medical Mission from 28 of 55 medical posts (51%) in the hinterland. None of these patients were registered at the dermatology departments in Paramaribo. Patient characteristics are given in Table 1. Figure 1B presents the age distribution of the patients by sex.

Figure 2 presents the distribution of the 55 medical posts. Table 3 presents the number of registered inhabitants, the number of medical posts per region, and the number of CLS patients. Most of the CLS patients were registered in Upper Suriname (N = 83, 51.2%), where most inhabitants were also registered (N = 23,818). The highest mean detection rate was found in the Brokopondo region, with 4.14 CLS patients per 1,000 inhabitants. Only 10% of the inhabitants of the forested hinterland are Amerindians, whereas 90% are Maroons. When the numbers of CLS patients were calculated per ethnic group, a mean detection rate was found of 2.45 CLS patients per 1,000 inhabitants for the Amerindians (15 CLS patients per 6,127 inhabitants) and 3.69 CL patients per 1,000 for Maroons (195 CLS patients per 52,907 inhabitants). In total, 32 of 39 (82.1%) medical posts located in Maroon villages registered CLS patients compared with only 5 of 16 (31.3%) medical posts in Amerindian villages.

**Table 2**

<table>
<thead>
<tr>
<th>Region of infection</th>
<th>N (%)</th>
<th>Infecting species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Suriname</td>
<td>1 (3%)</td>
<td>L. (V.) guyanensis</td>
</tr>
<tr>
<td>Brokopondo</td>
<td>17 (59%)</td>
<td>L. (V.) guyanensis*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L. (V.) lainsoni</td>
</tr>
<tr>
<td></td>
<td></td>
<td>L. (L.) amazonensis</td>
</tr>
<tr>
<td>East Suriname</td>
<td>5 (17%)</td>
<td>L. (V.) guyanensis</td>
</tr>
<tr>
<td>West Suriname</td>
<td>2 (7%)</td>
<td>L. (V.) guyanensis*</td>
</tr>
<tr>
<td>French Guiana</td>
<td>2 (7%)</td>
<td>L. (V.) guyanensis*</td>
</tr>
<tr>
<td>Unknown</td>
<td>2 (7%)</td>
<td>L. (V.) guyanensis</td>
</tr>
</tbody>
</table>

* In two patients L. (V.) guyanensis and L. (V.) lainsoni could not be distinguished.

L. (V.) guyanensis (complex) = L. (V.) guyanensis or L. (V.) lainsoni.

Figure 3 shows the number of registrations per month. Most patients were diagnosed in March (35%). However, the start date of clinical symptoms was not consequently reported on the questionnaires, so no conclusion could be drawn in this respect.

**Medical visits to the hinterland.** It was possible to examine 28 of the 162 CLS patients during their visits to the medical posts. One patient was also examined in the prospective study in Paramaribo and was excluded from this group as a result. Medical posts were visited in four different regions: Brownsweg in the Brokopondo region (11 patients), Gujaba in Upper Suriname (8 patients), Langetabetje, Nason, Gakaba and Apuma in East Suriname (7 patients), and Kwamalasamutu in South Suriname (1 patient). From these, 27 individual skin biopsies were collected and tested in mini-exon and hsp70 PCR. Fifteen patients tested positive in mini-exon and hsp70 PCR and were identified as L. (V.) guyanensis; 9 patients tested positive in mini-exon PCR [identified as L. (V.) guyanensis complex] but negative in hsp70 PCR, and 3 patients were negative in both assays. In the end, 24 of 27 CLS patients (88.9%) were positive for CL (95% CI, 77.1–100%).

**Estimation annual detection rate.** In total 162 CLS patients were registered by questionnaires. The Medical Mission Coordination center registered 48 CLS patients at 13 medical posts without completion of a questionnaire. In total, 210 individuals from the hinterland were considered CLS patients. Based on the PCR results of 27 examined patients (88.9% positive CL patients [95% CI, 77.1–100%]), the number of patients who were considered as truly positive...
TABLE 3

<table>
<thead>
<tr>
<th>Region</th>
<th>No. of medical posts</th>
<th>No. of registered inhabitants</th>
<th>No. of CL suspected patients (%)</th>
<th>Detection rate per 1,000 inhabitants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Upper Suriname</td>
<td>13</td>
<td>24,499</td>
<td>83 (51.2%)</td>
<td>3.39</td>
</tr>
<tr>
<td>2 Brokopondo</td>
<td>14</td>
<td>13,041</td>
<td>54 (33.3%)</td>
<td>4.14</td>
</tr>
<tr>
<td>3 East Suriname</td>
<td>12</td>
<td>15,538</td>
<td>19 (11.7%)</td>
<td>1.22</td>
</tr>
<tr>
<td>4 Central West</td>
<td>6</td>
<td>1,606</td>
<td>2 (1.2%)</td>
<td>1.25</td>
</tr>
<tr>
<td>5 West Suriname</td>
<td>3</td>
<td>1,802</td>
<td>3 (1.9%)</td>
<td>1.66</td>
</tr>
<tr>
<td>6 South East Suriname</td>
<td>4</td>
<td>1,293</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>7 South Suriname</td>
<td>3</td>
<td>1,255</td>
<td>1 (0.6%)</td>
<td>0.80</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>59,034</td>
<td>162</td>
<td></td>
</tr>
</tbody>
</table>

Distribution of medical posts (N = 55), number of registered inhabitants (N = 59,034), and number of registered CL suspected patients (N = 162) by means of questionnaires (Suriname, 2006)

- The number of CL suspected patients ranged between 162 (77.1%) and 210 (100%) patients. Besides the 33 CL confirmed patients from Paramaribo, 111 CL patients were registered at the dermatology department and 8 at the academic hospital. In total, the number of calculated CL patients in 2006 ranged from 314 (77.1%) to 362 (100%). Overall, a detection rate was found of 5.32 to 6.13 CL patients per 1,000 inhabitants for the whole country, 0.74 patients per 1,000 inhabitants for the forested hinterland and 0.64 to 0.74 patients per 1,000 inhabitants for the whole country throughout 2006.

**DISCUSSION**

This study is the first to report that some CL patients in Suriname are infected with species other than *L. (V.) guyanensis*, namely *L. (V.) lainsoni* or *L. (L.) amazonensis*. These species could be considered to be truly endemic, because the infected patients had never traveled outside the country. This study found a detection rate of CL infection for the whole country that was comparable to the mean annual incidence found between 1979 and 1985. However, our detection rates could not be annualized, which makes it hard to draw firm conclusions on the possible changing incidence rates of CL in Suriname.

The high *L. (V.) guyanensis* incidence rate in Suriname found in this study is comparable with the rate observed in French Guiana (95.8%), the neighboring country on the eastern border of Suriname where *L. (L.) amazonensis* (1.9%), *L. (V.) lainsoni* (0.5%), *L. (V.) braziliensis* (1.4%), and *L. (V.) naiffi* (0.5%) are also found to cause human CL infection. This study showed that some of these species are also present in Suriname. *L. (V.) lainsoni* is clinically not relevant and can be treated as similar to *L. (V.) guyanensis*. However, *L. (L.) amazonensis* can cause severe disease (i.e., the anergic diffuse form of CL), which is very difficult to treat. In our study, the *L. (L.) amazonensis*-infected patient from Suriname had disseminated CL for > 11 years and did not respond to the standard treatment with Pentamidine (van der Meide and others, unpublished data). *L. (V.) braziliensis*, although endemic in neighboring countries, has until now not been found in Suriname. Because this species can cause the destructive mucocutaneous form and needs to be treated with prolonged systemic medications, regular surveillance of the specific species that caused the disease in a patient remains important.

Most patients who visit the dermatology departments in Paramaribo are young adult men (82%) who enter the forest mostly for occupational activities. This is in contrast to the forested hinterland, where children and women accounted for 49% of the total registered patients. This may indicate that transmission often occurs within villages (intradomiciliary or peridomiciliary transmission) as described in a previous report. Therefore, more accurate studies are needed.

Many immigrant Brazilians are working in Suriname. Most of them probably originate from the same poor areas in the northern of Brazil as reported in French Guiana. No official registration of these immigrants is available, whereas some estimate the number to be ∼30,000 people (Leslie OA Sabajo, personal communication, 2007). Many of these immigrants are involved in gold mining, which increases the risk of exposure to infected vectors instantly. Risk of infection in gold mining villages can be 65 times higher than in other areas in the rainforest. It is known that many Brazilian workers are familiar with the disease and often obtain medications in Paramaribo for self-medication in the forested hinterland. In our study, we registered a very low number of Brazilian CL patients.

Amerindians have their own traditional treatment methods and do not seek treatment at the medical posts of the Medical Mission Coordinator Center. Many of these patients are likely not to have been included in this study. The mean detection and response rate was indeed lower for the Amerindians (2.45 CL patients per 1,000 inhabitants; 31.3% medical posts with CLS registrations) than for the Maroons (3.69 CL patients per 1,000 inhabitants; 82.1% medical posts with CLS registrations). Furthermore, this study was based on passive surveillance and not on a cross-sectional population-based survey, which would probably have led to a higher number of registrations. A study in Guatemala that compared active and passive case detection of CL showed that the numbers obtained through active case detection were 40 times higher than those obtained by passive detection. The true annual incidence of CL in Suriname is therefore likely to be
underestimated, because it was difficult to calculate the number of patients who are not registered in this study.

CL in Suriname is a seasonal disease. The rainy seasons are from November to January and from May to July. In this study, most patients were registered during the short dry season in March (35%). Unfortunately, the transmission period could not be determined, because the dates of onset of clinical symptoms were not properly recorded. Nevertheless, the most likely transmission period is between October and December, as in French Guiana, where a similar climate prevails.22 Flu3 has already described the rainy seasons as the most important season for CL transmission. Global warming is likely to affect this seasonal pattern of transmission, because climate and CL transmission seem to be related.23 Although some researchers predict little change in the geographical distribution and incidence of CL,24 others suggest that global warming is likely to increase the incidence of the disease in some areas in the northern part of South America.25

Although there is proper health care in the hinterland of Suriname, there is still uncertainty about actual rates of CL incidence, population size, turnover, and migration routes. Patients in the hinterland of Suriname receive Pentamidine treatment (the only standard treatment available in Suriname) free, but the cost of this treatment in Paramaribo is high (~90 USD per treatment) and often beyond the income of most patients. This may result in inadequate treatment, which could lead to certain patients remaining as reservoirs for infection. In addition, other Leishmania species can easily be introduced into Suriname from neighboring countries. This study emphasized this concern, because two new species for Suriname were identified in only a very small study group, one of which had major clinical implications. This shows that there is an urgent need for larger studies, not only to identify more Leishmania isolates and quantify CL incidence more accurately, but also to identify risk factors and socioeconomic consequences to introduce appropriate and effective prevention and control strategies.

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