Volume 50, Number 2
Printed in the U.S.A.

Syphilis in Patients with Hansen's Disease[1,2,3]

Katherine A. Murray[4]

The importance of serological testing for syphilis has been well-documented ([8]), and Hansen's disease (HD—leprosy) is one of several conditions associated with chronic false positive test results for reagin ([4,12,29]). However, a high prevalence of syphilis has been suspected in leprosy patients ([12,29]), but this has not yet been documented by any studies using clinicopathological criteria as well as serological tests. At the National Hansen's Disease Center in Carville, Louisiana, U.S.A., a study of all HD patients seen between 1975–1979 was conducted in order to evaluate the frequency of syphilis in this population.

Invasion of the human by *Treponema pallidum*, the spirochete which causes syphilis, leads to the production of two types of antibodies: a) nonspecific antibodies or "reagin" directed against the lipoidal antigens of *T. pallidum*, some of which cross react with cardiolipin, and b) specific antitreponemal antibodies measured in tests using the treponeme itself as antigen ([31]). The VD Research Lab (VDRL) slide tests or rapid plasma reagin (RPR) card tests are used in screening populations for syphilis but, within any group, 18% to 55% of the positive VDRL reactors will be false positive ([10,16,22]). Therefore specific treponemal tests are needed to confirm the diagnosis of syphilis in a positive VDRL or RPR reactor.

These tests include a) *T. pallidum* immobilization (TPI), b) indirect immunofluorescence with fluorescent treponemal antibody absorption (FTA-ABS), or c) microhemagglutination for *T. pallidum* (MHA-TP) using sheep erythrocytes coated with *T. pallidum* antigen ([16]). The FTA-ABS is more sensitive for diagnosing syphilis and is simpler to perform than the TPI, but both tests have equal specificity ([9,21,28,29]). Although the MHA-TP test is less expensive and simpler to perform, it is said to be less specific for syphilis in populations with HD or autoimmune diseases where a large number of false positive nontreponemal tests are found ([14]).

The Carville study was undertaken to ascertain the frequency of syphilis in the HD population. Unlike previous studies of HD patients in the Philippines ([12,14]), these patients had tuberculoid and borderline (dimorphous) as well as lepromatous Hansen's disease. The RPR card test was used rather than the VDRL slide test since the RPR has been shown to be more specific for syphilis than the VDRL with HD sera ([12,14,29]). The FTA-ABS was used as a treponemal test because the FTA-ABS appears to be more sensitive for detecting primary syphilis ([28,29]) and more specific than hemagglutination tests in HD sera ([14]).

METHODS

From 1975 to 1979, serology testing was done on 630 Carville patients with the quantitative RPR card test ([25]) (Macro-Vue, Brewer Diagnostic, Baltimore, Maryland, U.S.A.) and FTA-ABS (Clinical Sciences, Whippany, New Jersey, U.S.A.). RPR titers were quantified by serial dilutions and FTA-ABS positivity was assessed visually as "borderline," +1, +2, +3, or +4. All FTA-ABS tests were conducted and read by the same registered medical technologist. Many patients had several serology samples taken throughout the four-year period, comprising a total of 1002 specimens examined. Annual results were tabulated and the maximum titer and/or level of fluorescence was used to categorize each positive reactor.

The cumulative serological results for

[1] Received for publication on 4 August 1981; accepted for publication in revised form on 10 November 1981.

[2] Presented in part at the 16th Annual Meeting of the P.H.S. Professional Association, 28 May 1981, Boston, Massachusetts, and at the 1st World Congress on Sexually-Transmitted Diseases, 19 November 1981, San Juan, Puerto Rico.

[3] Use of trade names is for identification only and does not indicate endorsement by the U.S. Public Health Service.

[4] K. A. Murray, M.D., Staff Physician, National Hansen's Disease Center, Carville, Louisiana 70721, U.S.A.

TABLE 1. *Serological tests for syphilis on 630 Carville patients, 1975–1979.*

RPR	FTA-ABS	Number	Percent	Percent of positives	Group
Negative	Negative	501	79.6	—	—
Positive	Positive	63	10.0	48.8	I
Positive	Negative	49	7.7	38.0	II
Negative	Positive	17	2.7	13.2	III
Total		630	100	100	

each patient were tabulated together with the patient's age, sex, ethnic group, Ridley-Jopling HD classification ([26]), HD activity, and yes-no categorization as to the presence of erythema nodosum leprosum (ENL) or reversal reactions. Each chart was also reviewed for previous history of treponematosis clinically and/or serologically (positive TPI), previous history for nonluetic venereal disease, and whether the treponematosis was treated. Although darkfield examinations were unavailable, a painless genital chancre with regional lymphadenopathy, Charcot joints of the knees, tabes dorsalis, paranoia and personality changes consistent with neurosyphilis, condyloma lata, optic atrophy without a history of methanol or toxin exposure, and either positive serology or history of syphilis in a spouse without HD were among the criteria consistent with a past history of syphilis. In one case syphilis was verified only on postmortem examination.

The patient age distributions were compared using a single factor or one-way analysis of variance to generate an F value or variance ratio. The Bartlett's test for homogeneity of variance was used to evaluate age differences among the three seropositive groups. Chi-square analyses were used to evaluate all other parameters. Significance was assessed at the 5% level of probability ($p = 0.05$).

RESULTS

Most patients were seronegative to both tests, but 20% were positive to the RPR and/or FTA-ABS tests (Table 1). One hundred twelve (17.7% of the total) had positive RPR's; while 80 patients (12.7% of the total) had positive FTA-ABS tests. Most of the positive patients, 63, (10% of the total) were reactive in both the RPR and the FTA-ABS; 49 (7.7%) were RPR reactive only; and 17 (2.7%) were reactive only with the FTA-ABS test. The three seropositive groups were studied in more detail and called groups I, II and III, respectively.

Table 2 shows that each of the three groups were equivalent with respect to age, sex, HD classification, and HD activity. HD patients in all three groups were predominantly at the lepromatous (LL) or borderline lepromatous (BL) end of the Ridley-Jopling classification spectrum. Although 37 or 75% of the group II (RPR positive-FTA negative) patients had BL or LL HD, 7

TABLE 2. *Characterization of the 129 positive patients by serological group.*

	Group I (RPR+ FTA+)	Group II (RPR+ FTA−)	Group III (RPR− FTA+)
No. of patients	63	49	17
(% of total)	(49)	(38)	(13)
Mean age	59.7	53.5	61.7
(median)	(59)	(54)	(61)
No. of males	38	28	9
(% of group)	(60)	(57)	(53)
No. Hispanic patients	31	26	9
(% of group)	(49)	(53)	(53)
HD classification [No. (% of group)]			
BL or LL	46 (73)	37 (76)	14 (82)
Not leprosy	2 (3)	2 (3)	0 —
HD activity[a] [No. (% of group)]			
Active	25 (41)	22 (45)	6 (35)
Quiescent	9 (15)	6 (15)	3 (18)
Inactive	27 (44)	19 (40)	8 (47)
No. with ENL[b]	8	10	2
(% of group)	(13)	(21)	(12)

[a] Active HD means the patient had bacteriologically positive disease with demonstrable acid-fast bacilli by skin scrapings and/or skin biopsy. Quiescent HD means the patient had no demonstrable acid-fast bacilli on skin scrapings and a skin biopsy was pending.

[b] ENL means erythema nodosum leprosum, either clinically or on skin biopsy.

TABLE 3. *Venereal disease history and treatment by serological group. Numbers are number of patients (% of the group).*

	Group I (RPR+ FTA+)	Group II (RPR+ FTA−)	Group III (RPR− FTA+)
History of treponematoses			
Yes[a]	40 (63)	2 (4)	2 (12)
No	15 (24)	47 (96)	11 (65)
Unknown	8 (13)	0 –	4 (23)
Treponemal disease treated			
Yes[a]	44 (70)	8 (16)	8 (47)
No	15 (24)	35 (71)	4 (24)
Unknown	4 (6)	6 (12)	5 (29)
History of nonluetic venereal disease			
Yes	16 (25)	4 (8)	3 (18)
No	41 (65)	44 (90)	13 (76)
Unknown	6 (10)	1 (2)	1 (6)

[a] Statistically significant differences among the different groups.

TABLE 4. *Breakdown of serological positivity by serological group. Numbers are number of patients (% of the group).*

	Group I (RPR+ FTA+)	Group II (RPR+ FTA−)	Group III (RPR− FTA+)	Total
FTA > +1	50 (79)	0 —	5 (29)	55
FTA = NQ[a]	9 (14)	0 —	1 (6)	10
FTA ≤ +1	4 (6)	0 —	11 (65)	15
RPR > 1:1	53 (84)	20 (41)	0 —	73
RPR ≤ 1:1	10 (16)	29 (59)	0 —	39

[a] NQ means FTA results were not quantified or a titer was not reported.

cases of borderline (dimorphous) HD and 3 cases of tuberculoid HD had isolated RPR reactivity. Four of these ten non-lepromatous cases were clinically inactive with no acid-fast organisms on skin scrapings or skin biopsies.

More of the group II cases had reaction or ENL than the patients in the other two groups, but this was not statistically significant ($p = 0.35$).

As shown in Table 3, group I patients, or those with both RPR and FTA-ABS reactivity, gave a history of exposure to treponemes as well as nonluetic venereal disease most frequently. Although most cases were straightforward, one patient had yaws as a child; while another had syphilitic aortitis documented only on postmortem examination, with "tree-barking" of the intima and aneurysmal dilation of the ascending aorta. Some of the RPR positive-FTA positive patients were seen before TPI tests were phased out, and 23 out of 30 group I patients examined were positive with the TPI as well as the RPR and FTA-ABS tests. All 26 group I patients examined so far with the MHA-TP test (V.D. Control Division, Atlanta, Georgia, U.S.A.) have been MHA-TP reactive as well. Sixty-three percent of all group I patients had a history of syphilis and 70% had been treated for syphilis as of 1 January 1980.

Group II patients had the lowest frequency of treponemal and nonluetic venereal disease by history and clinical course. Ninety-six percent of them gave no history of treponemal exposure but 16% were treated anyway. A higher percentage (47%) of the group III patients received treatment for syphilis when compared with those in group II (16%).

All positive FTA-ABS tests were uniformly immunofluorescent in a homogeneous pattern. No abnormal or beaded forms were seen even among weakly reactive FTA-ABS specimens. As shown in Table 4, most (79%) of the group I specimens had highly positive FTA-ABS tests. At least 36 of these 63 sera had brightly fluorescent FTA-ABS tests, of grades +3 or +4 positivity by visual assessment. Likewise, all but two of the +3 to +4 tests were from group I specimens and associated with positive RPR tests. Most (65%) of the "borderline" or +1 FTA-ABS cases were associated with negative RPR tests.

Most of the high-titered RPR specimens, as with the strongly immunofluorescent FTA-ABS tests, were associated with group I sera. Conversely, 74% (29/39) of the low-titered RPR cases were associated with negative FTA-ABS tests. Group II specimens with RPR titers of 1:1 or less, including those weakly reactive, included all sera from the ten dimorphous and tuberculoid cases of group II. All the high-titer group II leprosy cases had lepromatous HD and RPR titers from 1:2 to 1:32 dilutions. But one non-leprosy case was admitted to Car-

ville with RPR titers of 1:16 and a negative FTA-ABS test. She was a 26-year-old woman presenting with lupus dermatitis who had an inherited C2 or complement deficiency disease and systemic lupus erythematosus ([23]).

Reviewing each patient's history, clinical findings, and serological results revealed that Group I patients represented those recently treated for syphilis, those treated for tertiary or late latent disease, or those with untreated syphilis. Group II patients were biological false positive reactors to the RPR card test. Group III patients were either treated syphilitics or possible false positive FTA-ABS cases. Among these 17 group III patients, 1 had a positive and 3 had negative TPI tests. One patient had a reactive FTA-ABS (+1) which was nonreactive on repeat testing one year later with a nonreactive MHA-TP as well. Another group III case who was repeatedly FTA-ABS reactive had a reactive MHA-TP test also; he had been treated for syphilis decades ago.

DISCUSSION

Total RPR positivity was nearly 18% in this large population of HD patients, more than the 3% to 10% seen in the general population or in a large population of screened refugees ([5, 8, 10, 24]) but equivalent to that seen in drug addicts, lupus patients, or even HD patients from the previous decade. It has been reported that 15% of drug addicts, 16% of lupus patients, and 4% to 19% of all HD patients were reactive to the VDRL and/or the RPR serology tests for syphilis and almost half of these seropositive cases were false positive ([12, 17, 19, 29]). In this study of leprosy sera, just under one half or 44% of all RPR positive cases were false positive with a negative FTA-ABS test and neither historical nor clinical evidence of treponemal infection.

Like most HD cases in the Western Hemisphere, the majority of the false positive RPR reactors had lepromatous HD but there were a few borderline (dimorphous) and tuberculoid cases as well, a fact not yet reported in the literature. False positive specimens from borderline and tuberculoid cases, however, were always associated with low RPR titers.

Total FTA positivity in this study was 12.7%, comparable to that seen in the general population (1% to 17%) ([8, 10, 21, 24]) but higher than that seen in 250 lifelong celibate nuns (0.8%) ([15]). Although a few HD cases may represent a false positive immunofluorescence, drug addicts (6%), lupus patients (15%), and HD patients from the previous decade (19%) appeared to have a range of FTA positivity similar to that of normal populations ([17, 19, 29]).

The majority, or 56%, of the RPR positive HD cases were also reactive with the FTA-ABS test. These patients more frequently had a history of syphilis or treponemal disease as well as nonluetic venereal disease. They had high RPR titers and a strong degree of FTA-ABS immunofluorescence. If the predictive value (PV) of a positive test ([11]) is defined as:

$$PV = \frac{\text{true positives}}{\text{true positives} + \text{false positives}} \times 100\%$$

the predictive value for positivity of the ideal test (with no false positives) would be 100%. (This modified PV ratio is used because the actual prevalence of syphilis is unknown among HD patients at this time, i.e., the number of sero-negative syphilitics with HD is unknown). In our laboratory, the PV of the RPR test with high titers (1:2 to 1:64 dilutions) was only 72.6% for associated FTA-ABS reactivity and usually clinical and/or historical evidence of syphilis. But the highly-immunofluorescent FTA-ABS test was almost always associated with RPR reaginemia and seropositive syphilitic disease. Thirty-six out of the 38 seropositive specimens with grades +3 or +4 FTA-ABS fluorescence were associated with RPR positivity, yielding a PV of 94.7%; FTA-ABS reactivity of grades +2, +3, or +4 fluorescence carried a PV of 90.9% for RPR positivity. Thus RPR titers were less useful than highly positive FTA-ABS immunofluorescence (+3, +4) for predicting seropositivity with the other serological test for syphilis. Weak FTA-ABS immunofluorescence was inconclusive.

Patients treated for syphilis with penicillin, erythromycin, or tetracycline ([32]) experience a variable degree of seroconversion depending upon the time course between exposure resulting in infection and

TABLE 5. *Serological studies with HD patients. Numbers are the percentage of the total number of sera tested in each study.*

Study	Garner, *et al.*, 1969 [13]	Garner and Backhouse, 1972 [12]	Scotti, *et al.*, 1970 [29]	Present study
No. of sera studied	270 (100%)	269 (100%)	206 (100%)	630 (100%)
RPR− FTA−	92%	90%	80%	79%
RPR− FTA− VDRL+	10%	9%	19%	—
RPR+ FTA+ (Group I)	3	5	15	10
RPR+ FTA− (Group II)	1	4	<1	8
RPR− FTA+ (Group III)	4	<1	5	3

treatment. Strict microbial and serological cure is achieved only if treatment is given within the first two years of infection [2,4]. Those with tertiary or late latent syphilis treated many years after the initial infection may remain serofast with a positive RPR and FTA-ABS for life. But some patients treated for secondary or late disease may become RPR negative in the next few months while the FTA-ABS remains positive for years. Thus 97% of untreated or partially treated syphilitics are said to have a positive FTA-ABS 30 years after infection [27], sometimes with a negative nontreponemal serology test. Using RPR negative-FTA positive specimens, further studies would be needed with another treponemal test to differentiate treated syphilis from a possible false positive FTA-ABS with HD sera.

Previous reports on HD sera as well as the present communication show that isolated FTA-ABS reactivity is uncommon (Table 5) [12,13,29]. It is unclear how many group III cases represented treated syphilitics and how many may have been transiently false positive FTA-ABS tests. Garner, *et al.* in 1973 conducted *T. pallidum* hemagglutination tests (TPHA, using turkey rather than sheep red blood cells) on 267 lepromatous HD patients from the Philippines [14]. They found only 14 cases of syphilis (5%) and all 14 were reactive with the FTA-ABS, TPI, and TPHA tests. No cases of isolated FTA-ABS reactivity were seen but seven non-syphilitic HD cases had isolated TPHA reactivity with nonreactive FTA-ABS and nonreactive TPI tests. There was nothing to suggest a possible false positive FTA-ABS, and the authors commented only upon the poor specificity of the TPHA test. In our study with the FTA-ABS test, we saw no abnormal or beaded forms of fluorescence among over 1000 specimens examined, as is reportedly seen with some false positive FTA-ABS cases of systemic lupus erythematosus, rheumatoid arthritis, or other autoimmune diseases [18,20,30]. However, typical homogeneous fluorescence with presumably no treponemal exposure has been reported in pregnancy [3].

HD, especially when accompanied by reversal reaction or ENL, shares several signs and symptoms with syphilis. The collapsed nose (rhinopharyngitis mutilans), a multiplicity of skin rashes, and peripheral neuropathy associated with extremity ulceration may be seen in both diseases. Keratitis, uveitis, and orchitis occur in reactional HD as well as in syphilis [1,33]. Although only syphilis causes atrophy of the optic disc, both diseases may be associated with Charcot joints of the lower extremities. There are similarities between the two diseases and extragenital syphilitic lesions could be masked by active lepromatous leprosy particularly if the patient also had ENL.

This study, reviewing four years of serological data from over 600 Carville patients, found about 60 patients with both HD and syphilis. These patients were true positive serological reactors with clinical and/or historical evidence of syphilis and seroreactivity to both the RPR and FTA-ABS tests. A few previously untreated cases, initially thought to be false positive reactors to both tests, showed manifestations of tertiary or late syphilis on further evaluation. It is clear that syphilis appears more commonly in HD patients than in the general population, with rates higher than the 30 cases per 100,000 cited for the U.S. at large [6,7], and that withholding antibiotic treatment from an untreated HD patient with

both RPR and FTA-ABS reactivity, particularly if the FTA-ABS is strongly immunofluorescent (+3, +4), is not justified. Each HD patient with a positive RPR and a positive FTA-ABS test should be seriously evaluated for syphilis, and, if not yet treated, the patient should be treated.

SUMMARY

Between 1975 and 1979, 630 patients with leprosy or Hansen's disease (HD) were examined clinically and screened for syphilis using both the rapid plasma reagin (RPR) and fluorescent treponemal antibody absorption (FTA-ABS) tests. Seropositive syphilis was found more frequently than in the general population; 10% were true positive reactors with a reactive RPR, a reactive FTA-ABS, and historical, clinical, and/or postmortem evidence of syphilis. Only 8% exhibited false positive tests for reagin with a negative FTA-ABS and neither historical nor clinical evidence of treponemal infection. Among those with FTA-ABS test reactivity, highly positive FTA-ABS immunofluorescence (+3, +4) was highly predictive for syphilis (94.7%). Seropositive HD patients with both RPR and FTA-ABS reactivity should be seriously evaluated for syphilis and, if not yet treated, they should be treated.

RESUMEN

Entre 1975 y 1979, se estudiaron 630 pacientes con lepra lepromatosa o enfermedad de Hansen (HD) tanto desde el punto de vista clínico como desde el punto de vista de una posible infección sifilítica. Esta se estableció usando la prueba rápida para reagínas plasmáticas (RPR) y la prueba fluorescente de la absorción del anticuerpo anti-treponema (FTA-ABS). Se encontró que le seropositividad para sífilis fue más frecuente en los enfermos de Hansen que en la población general; 10% de los casos fueron verdaderos reactores positivos, con evidencias históricas, clínicas, o postmortem, de sífilis. Sólo 8% de los casos dieron pruebas positivas falsas para reagínas (PRP), con una prueba FTA-ABS negativa y sin evidencias históricas o clínicas de infección treponemal. Entre aquellos positivos por la prueba FTA-ABS, una prueba francamente positiva (3+, 4+) fue altamente predictiva de sífilis (94.7%). Los pacientes con HD que resulten positivos por ambas pruebas deben examinarse cuidadosamente para establecer la infección sifilítica y, en su caso, deben recibir el tratamiento apropiado si aún no lo reciben.

RÉSUMÉ

Entre 1975 et 1979, 630 malades atteints de lèpre (maladie de Hansen) ont été examinés cliniquement, afin d'identifier ceux qui étaient atteints de syphilis, par une méthode utilisant, à la fois, la réaction rapide de la réagine plasmatique (RPR), et des épreuves fluorescentes d'absorption des anticorps treponémiques (FTA-ABS). Les malades se sont révélés plus fréquemment atteints de syphilis séropositive que la population générale. Le taux de vrais positifs, c.à.d. d'individus réagissant positivement pour le RPR, le FTA-ABS, et présentant soit des antécédents de syphilis, soit des manifestations cliniques de la maladie, soit des lésions mises en évidence à l'autopsie, atteignait 10%. La proportion de malades présentant des épreuves faussement positives pour la réagine, avec un FTA-ABS négatif, et aucune évidence anamnestique ou clinique d'infection par tréponèmes atteignait 8%. Parmi les individus réagissant positivement à l'épreuve des anticorps fluorescents (FTA-ABS), des résultats fortement positifs pour cette épreuve (3+, 4+) se sont révélés dotés d'une valeur hautement prédictive pour la syphilis (dans 94,7%). Les malades hanséniens séropositifs réagissant à la fois à l'épreuve à la réagine (RPR) et aux anticorps fluorescents (FTA-ABS), devraient être sérieusement étudiés en vue de mettre en évidence une syphilis éventuelle, et s'ils n'ont pas encore été traités pour cette maladie, ils devraient l'être.

Acknowledgments. The author thanks Mr. Stephen E. Keas who performed all RPR and FTA-ABS tests in the hospital's clinical laboratory. The author acknowledges the computer assistance of Mr. Melvyn Morales and the consultative aid provided by the Louisiana State University Department of Experimental Statistics (Baton Rouge). The author thanks Dr. Robert R. Jacobson, the Carville Editorial Committee, Dr. Howard Jaffe and his associates of the Center for Disease Control, Atlanta, Georgia, and Dr. A. Howard Fieldsteel (SRI, California) for reviews and commentary, and Ms. Sally Stoewer for secretarial preparation of the manuscript.

REFERENCES

1. Allen, J. H. and Brand, M. Ocular Leprosy. In: *Microbiology of the Eye*. Locatcher-Khorazo, D. and Seegal, B.C., eds. St. Louis, Missouri: C. V. Mosby, 1972, pp. 131–155.
2. Atwood, W. G., Miller, J. L., Stout, G. W. and Norins, L. C. The TPI and FTA-ABS tests in treated late syphilis. JAMA **203** (1968) 549–551.
3. Buchanan, C. S. and Haserick, J. R. The FTA-ABS test in pregnancy. Arch. Dermatol. **102** (1970) 322–325.
4. Catterall, R. D. Systemic disease and the biological false positive reaction. Br. J. Vener. Dis. **48** (1972) 1–12.
5. Center for Disease Control, Atlanta. Fol-

low-up on the health status of Cuban refugees. Morb. Mortal. Weekly Report **29** (1980) 343–344.
6. Center for Disease Control, Atlanta. Sex. Transm. Dis. Stat. Letter, No. 128. C.D.C., U.S. Dept. of Health and Human Services, Public Health Service, 1978.
7. Chase, A. Health News Commentary: Time Bomb, Hospital Tribune, March 1980, p. 23.
8. Cohen, P., Stout, G. and Ende, N. Serological reactivity in consecutive patients admitted to a general hospital. Arch. Int. Med. **124** (1969) 364–367.
9. Deacon, W. E., Lucas, J. B. and Price, E. V. FTA-ABS test for syphilis. JAMA **198** (1966) 624–628.
10. Drusin, L. M., Topf-Olstein, B. and Levy-Zombek, E. Epidemiology of infectious syphilis at a tertiary hospital. Arch. Int. Med. **139** (1979) 901–904.
11. Galen, R. S. and Gambino, S. R. *Beyond Normality. The Predictive Value and Efficiency of Medical Diagnoses*. New York: Wiley and Sons, 1975, pp. 2–51.
12. Garner, M. F. and Backhouse, J. L. The RPR (circle) card test in biological false positive and leprosy sera. J. Clin. Pathol. **25** (1972) 786–788.
13. Garner, M. F., Backhouse, J. L., Collins, C. A. and Roeder, P. J. Serological tests for treponemal infection in leprosy patients; an evaluation of the FTA-ABS test. Br. J. Vener. Dis. **45** (1969) 19–22.
14. Garner, M. F., Backhouse, J. L., Daskapoulos, G. and Walsh, J. L. The *Treponema pallidum* hemagglutination (TPHA) test in biologic false positive and leprosy sera. J. Clin. Pathol. **26** (1973) 258–260.
15. Goldman, J. N. and Lantz, M. FTA-ABS and VDRL slide test reactivity in a population of nuns. JAMA **217** (1971) 53–55.
16. Jaffe, H. W., Larsen, S. A., Jones, O. G. and Dans, P. E. Hemagglutination tests for syphilis antibody. Am. J. Clin. Pathol. **70** (1978) 230–233.
17. Kaufman, R. E., Weiss, S., Moore, J. D., Falcone, V. H. and Weisner, P. J. Biological false positive serological tests for syphilis among drug addicts. Br. J. Vener. Dis. **50** (1974) 350–353.
18. Kraus, S. J., Haserick, J. R. and Lantz, M. A. Atypical FTA-ABS test fluorescence in lupus erythematosus patients. JAMA **211** (1970) 2140–2141.
19. Kraus, S. J., Haserick, J. R. and Lantz, M. A. Fluorescent treponemal antibody absorption test reactions in lupus erythematosus. N. Eng. J. Med. **282** (1970) 1287–1290.
20. Kraus, S. J., Haserick, J. R., Logan, L. C. and Bullard, J. C. Atypical fluorescence in the FTA-ABS test related to DNS antibodies. J. Immunol. **106** (1971) 1665–1669.
21. Mackey, D. M., Price, E. V., Knox, J. M. and Scotti, A. Specificity of the FTA-ABS test for syphilis. JAMA **207** (1969) 1683–1685.
22. Moore, J. E. and Mohr, C. F. Biological false positive serologic tests for syphilis. JAMA **150** (1952) 467–473.
23. Osterland, C. K., Espinoza, L. and Parker, L. P. Inherited C2 deficiency and systemic lupus erythematosus: studies on a family. Ann. Int. Med. **82** (1975) 323–328.
24. Peter, C. R., Thompson, M. A. and Wilson, D. L. False positive reactions in the rapid plasma reagin card, fluorescent treponemal antibody-absorbed, and hemagglutination treponemal syphilis serology tests. J. Clin. Micro. **9** (1979) 369–372.
25. Portnoy, J. Modification of the rapid plasma reagin (RPR) card test for syphilis use in large scale testing. Amer. J. Clin. Pathol. **70** (1963) 473–479.
26. Ridley, D. S. and Jopling, W. H. A classification of leprosy for research purposes. Lepr. Rev. **33** (1962) 119–128.
27. Rockwell, D. H., Yobs, A. R. and Moore, M. B. The Tuskegee study of untreated syphilis: the 30th year of observation. Arch. Intern. Med. **114** (1964) 792–798.
28. Schroeter, A. L., Lucas, J. B., Price, E. V. and Falcone, V. H. Treatment for early syphilis and reactivity of serologic tests. JAMA **221** (1972) 471–476.
29. Scotti, A. T., Mackey, D. M. and Trautman, J. R. Syphilis and biological false positive reactors among leprosy patients. Arch. Dermatol. **101** (1970) 328–330.
30. Sepetjian, M., Monier, J. C., Thivolet, J., Tissot-Guerraz, F. and Salussola, D. False positive cardiolipid and FTA serological tests in patients with antinuclear antibodies. Pathol. Biol. **24** (1976) 397–400.
31. Sparling, P. F. Diagnosis and treatment of syphilis. New Eng. J. Med. **284** (1971) 642–653.
32. VD Control Division, Center for Disease Control. Syphilis—Recommended Treatment Schedules 1976. Morb. Mortal. Weekly Report **25** (1976) 101–108.
33. Whitefield, R. and Wirostko, E. Ocular syphilis. In: *Microbiology of the Eye*. Locatcher-Khorazo, D. and Seegal, B. C., eds. St. Louis, Missouri: C. V. Mosby, 1972, pp. 322–349.