

Immigration and Leprosy in Hawaii, 1960–1981<sup>1</sup>Robert M. Worth and Mona R. Bomgaars<sup>2</sup>

The immigrant-induced leprosy epidemic among Hawaiians<sup>3</sup> started in the 1840s (<sup>4</sup>) and reached its peak between 1890 and 1910 (<sup>2</sup>). During the next 40 years (before sulfone drugs) it declined steadily, to the point where it had disappeared entirely in at least one rural population by the 1950s (<sup>8</sup>).

The liberalization of United States' immigration rules in 1965 gave rise to a large increase in immigration to Hawaii from other Pacific islands and Asia, where leprosy is endemic. Since then immigrant leprosy cases with an onset in Hawaii have risen from an earlier average of about seven per year to a current level of about 30 new cases per year. Since 1965 there have been only 49 new Hawaii-born cases entered into the Hawaii Department of Health (DOH) case registry; while 360 new immigrant cases [130 with the borderline lepromatous or lepromatous (BL/L) form of the disease] have been entered into the registry.

The primary purpose of this study was to review records of all new Hawaii-born cases during the past 21 years for any trends that might reveal the impact of the rising number of immigrant BL/L cases upon Hawaii's population. This concern is accentuated by the fact that at the end of 1969 the DOH adopted a more humane policy (see Appendix) which substituted the "chemical isolation" of drug treatment of BL/L cases at home instead of prolonged isolation in an institution.

**MATERIALS AND METHODS**

Since 1874, the DOH has maintained a registry into which every case of reported leprosy has been entered, a sequential

search of which from July 1960 through June 1981 identified 100 new Hawaii-born cases, 95 of whom were used for this study.<sup>4</sup> Occasional reference to a case record was required for verification or amplification of data in the registry. Record abstracts available for those currently in the active registry served as the source of information on exposure history in most of these 95 cases. The 21 years reviewed were divided into three equal periods to compute statewide and local district trends.

**RESULTS**

Table 1a shows that for all except the 40 to 59 age group there was a steep drop in the number of new cases from the first to the second seven-year period. For those over age 19 at onset there has been a plateau during the past 14 years; while the fall in incidence for those under 20 has continued across all three periods. This has resulted in a rise in the median age of new cases, from 34 years in the early 1960s to 43 years recently (Table 1b).

Among Hawaiians there has been a dramatic fall in incidence under age 40, with only four new cases appearing in the past seven years, compared with 26 new cases in the first seven-year period reviewed. Even though Hawaiians continue to produce almost all the BL/L cases, the number of BL/L cases has dropped from an average of 2.3 per year in the first period to 0.3 per year recently (Table 1c).

Table 1d shows the ethnic distribution of new cases in the three time periods without regard to age at onset. In the early 1960s the Hawaiians were producing 88% (43/49) of the new cases among local-born people, but this proportion has fallen to 48% (10/21) due not only to the decline in the number of Hawaiian cases, but also to the rise of new local-born cases among other ethnic groups. Even among these other groups,

<sup>4</sup> Three cases were excluded because they had spent most of their childhoods in the Philippines, and two more because they did not fully meet diagnostic criteria.

<sup>1</sup> Received for publication on 1 February 1982; accepted for publication in revised form on 1 April 1982.

<sup>2</sup> R. M. Worth, M.D., Ph.D., School of Public Health, University of Hawaii at Manoa, Biomedical Sciences Building, Court D, 1960 East West Road, Honolulu, Hawaii 96822, U.S.A.; M. R. Bomgaars, M.D., M.P.H., Department of Health, State of Hawaii, Honolulu, Hawaii, U.S.A.

<sup>3</sup> The term "Hawaiians" is used throughout to include all those with full or partial ethnic Hawaiian ancestry.

TABLE 1. *Distribution of 95 new Hawaii-born cases of leprosy during three seven-year periods, by age at onset (or first diagnosis) and ethnic group.*<sup>a</sup>

	Time of onset (or first diagnosis)			Totals
	7/60-6/67	7/67-6/74	7/74-6/81	
a) Age at onset				
60+	7 ( 6 Hwn) <sup>b</sup>	2 (2 Hwn)	3 (2 Hwn)	12
40-59	12 (11 Hwn)	10 (9 Hwn)	9 (4 Hwn)	31
20-39	20 (17 Hwn)	9 (7 Hwn)	7 (3 Hwn)	36
<20	10 ( 9 Hwn)	4 (0 Hwn)	2 (1 Hwn)	16
Totals	49 = 7/year	25 = 3.6/year	21 = 3/year	95
b) Median age	34 years	39 years	43 years	
c) No. of BL/L cases	21 (16 Hwn)	6 (6 Hwn)	2 (2 Hwn)	
d) Ethnic group				
Hawaiian	43 (6.3/yr)	18 (2.6/yr)	10 (1.4/yr)	
Filipino	1	3	3	
Samoan	0	1	1	
Japanese	4	2	3	
Other	1	1	4	
Total	49	25	21	

<sup>a</sup> Source: Hawaii Leprosy Registry, July, 1960 through June, 1981.

<sup>b</sup> Hwn = Hawaiian.

however, in the past seven years there was only one new "early" (under age 20) local-born case, a Samoan child. The other ten non-Hawaiian cases in the past seven years

TABLE 2. *Cumulative leprosy incidence from birth to 1981 in four successive five-year birth cohorts, by ethnic group, Hawaii, 1950-1969.*

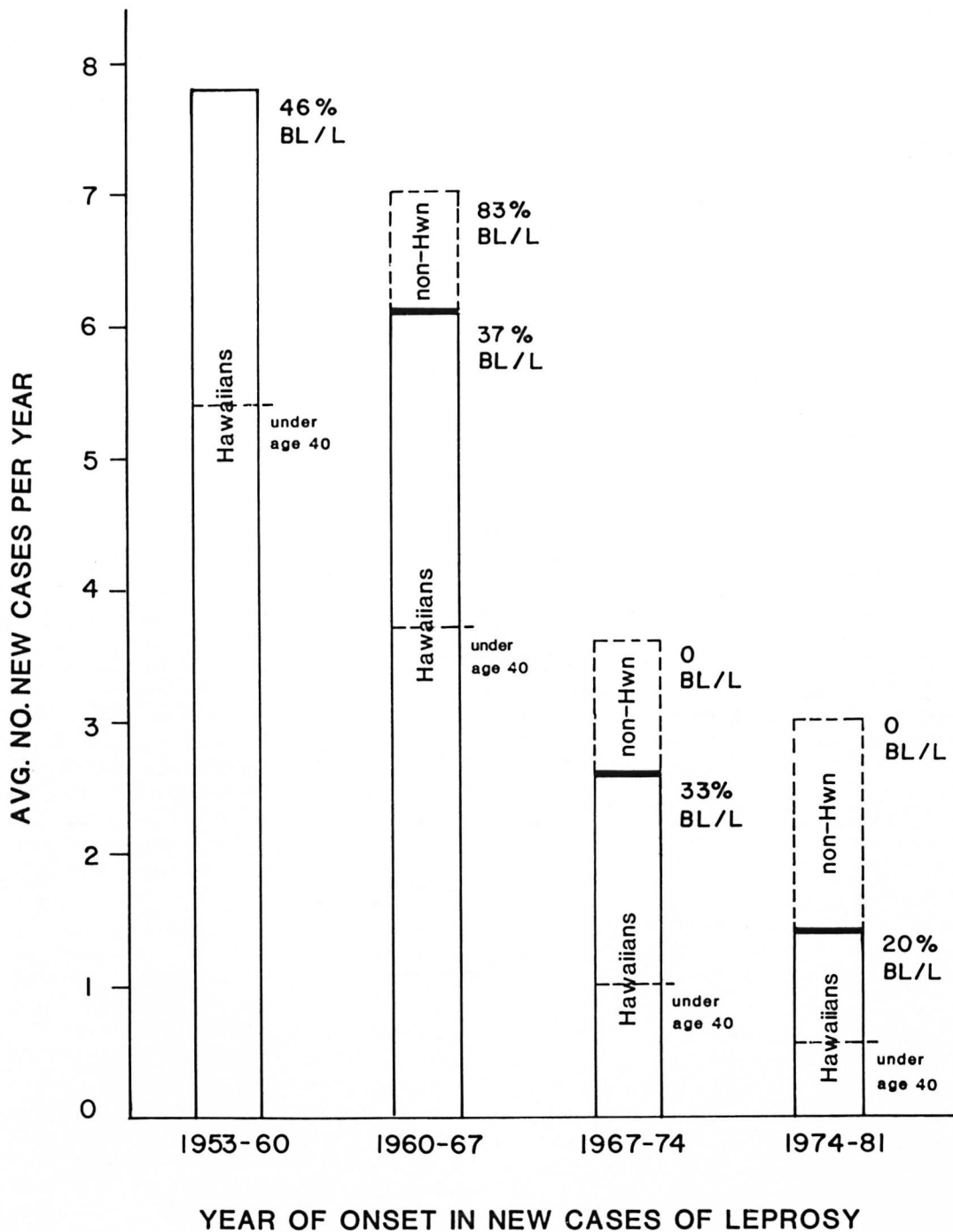
Birth years	Approx. no. births per 5 years	No. cases under age 20	No. cases age 20+	Totals
1950-54	Hawaiian 21,000	4	2	6
	Japanese 20,000	0	0	0
	Filipino 9,000	0	0	0
	Samoan ?	0	0	0
1955-59	Hawaiian 22,500	2	2	4
	Japanese 21,500	1	0	1
	Filipino 9,500	2	0	2
	Samoan ?	0	0	0
1960-64	Hawaiian 24,000	2	0	2
	Japanese 18,000	0	0	0
	Filipino 9,500	0	0	0
	Samoan 1,300	0	0	0
1965-69	Hawaiian 22,500	0	-	0
	Japanese 13,000	0	-	0
	Filipino 7,500	0	-	0
	Samoan 800	1	-	1

have been over age 29, six of whom were over age 40 at the time of onset.

Of the 71 Hawaiian cases only three (one in each time period, none under age 20) almost certainly (by history) acquired the infection from an unknown immigrant BL/L case. The remaining Hawaiian cases are mostly from families who have been known to the leprosy program for the past two or three generations.

The Figure summarizes the data from Table 1, plus a prior seven-year period for the Hawaiians only. Since the registry does not include birthplace before 1960, the non-Hawaiian local cases cannot be accurately identified before then and were therefore omitted for the 1953 to 1960 period.

Table 2 is a cohort analysis of leprosy experience among Hawaiian children. The 21,000 Hawaiian/part-Hawaiian babies born during the period 1950 through 1954 have shown an "early" (under age 20) attack rate of 0.19 per 1000 babies. This risk fell to 0.04 per 1000 for the 1965 through 1969 cohort. For later (possibly adolescent peer group) transmission the 1950 through 1954 cohort attack rate was 0.09 per 1000, falling to zero for the 1960 through 1964 group. It is too early to make a statement about "late" cases in the 1965 through 1969 birth cohort.



THE FIGURE. Average annual incidence of new Hawaii-born cases of leprosy during four successive seven-year periods, Hawaii Leprosy Registry, 1953-1981.

Corresponding birth cohorts of varying sizes for other ethnic groups have produced 2 Filipino, 1 Japanese, and 1 Samoan "early" local-born cases.

Table 3 shows residual disease, mostly in known Hawaiian families, in four districts on the island of Hawaii. The Puna and Hamakua districts appear to have become free

TABLE 3. Distribution of 95 new Hawaii-born leprosy cases by district of residence at the time of onset.<sup>a</sup>

Islands Districts	No. of cases	(No. of Hawaiian)	Years since last indigenous case
<i>Hawaii</i>			
Ka'u (South)	4	(4)	4
Kona (West)	7	(5)	6
Kamuela/Kohala (North)	4	(4)	7
Hamakua (N.E.)	0	0	>21 <sup>b</sup>
Hilo (town)	7	(5)	5
Puna (S.E.)	1 <sup>c</sup> not BL/L	0	6 <sup>b</sup>
<i>Niihau</i>	0	0	>40 <sup>b,d</sup>
<i>Kauai</i> (West)	0	0	>40 <sup>b,d</sup>
(East)	3	(1)	8
<i>Lanai</i>	0	0	>21 <sup>b</sup>
<i>Maui</i>			
Lahaina (West)	5	(5)	1
Paia/Haiku (N.E.)	6	(6)	8
Hana/Kaupo (S.E.)	5	(5)	8
<i>Molokai</i>	2 <sup>c</sup> not BL/L	(2)	7 <sup>b</sup>
<i>Oahu</i>			
Wahiawa/Kaaawa (N., N.E.)	4	0	3
Waianae/Nanakuli (West)	5	(4)	1
Kailua/Waimanalo (S.E.)	4 <sup>c</sup>	(4)	18 <sup>b</sup>
Kahaluu/Kaneohe (East)	5	(3)	5
Urban Honolulu	33 <sup>c</sup>	(23)	0
TOTAL	95	(71)	

<sup>a</sup> Source: Hawaii Leprosy Registry, 1960-1981.

<sup>b</sup> Probably free of indigenous transmission by now.

<sup>c</sup> People who grew up in another rural endemic district of Hawaii and had the onset of leprosy after moving to this district.

<sup>d</sup> Worth, R. M. The disappearance of leprosy in a semi-isolated population. *Int. J. Lepr.* 31 (1963) 34-35.

of indigenous transmission. Kauai's Niihau and west-side districts have been completely free. The three east-side cases consisted of one aged non-Hawaiian, with unknown source (perhaps many years earlier), plus two young adult cases, each with known exposure to untreated BL/L cases. The island of Lanai appears to have become free of indigenous disease, as has Molokai, whose two cases were apparently imported from Oahu and Maui. Maui continues to have residual disease among known Hawaiian families in three districts.

On Oahu the entire central area from Wahiawa to the north shore and around to the northeast coast is free of disease among Hawaiians; the new cases in that area being four local Filipinos, two with known exposure to immigrant cases. There is still residual disease among Hawaiians on the leeward coast and along the windward coast; however the last case from the Kailua-Wai-

manalo area appeared 18 years ago. Urban Honolulu (37% of the state's population) produced one third of all new indigenous cases, with a mix of local transmission, people moving in from known rural foci, and four with exposure to immigrant cases as the probable source.

Overall, among these 95 Hawaii-born cases who got their disease from exposure in Hawaii, only 10 probably had a recent immigrant case as a source, and only 3 of these were Hawaiian, of whom only 1 had her onset in the past seven years.

## DISCUSSION

The steady and steep decline in the number of new Hawaiian leprosy cases in the past 21 years, particularly among those under age 40 (only four such cases in the past seven years) is a very encouraging sign in the segment of Hawaii's population that has

traditionally been the most susceptible. This decline has occurred despite the 130 new BL/L immigrant leprosy cases since 1965, despite the policy of ambulatory treatment since 1970, and despite evidence from DOH records that the diagnosis is not being made earlier, nor is drug compliance improving in the decade since the policy was changed.

It therefore appears probable that changing social patterns are more likely than medical activities to be principally responsible for the lack of new disease in Hawaiian children and the rarity of cases due to exposure after childhood. There are several alternative explanations for the falling attack rate among Hawaii-born people:

- 1) It seems unlikely that this falling rate is an artifact due to deterioration of case finding because:
  - a) The removal of compulsory isolation in 1969 removed one of the incentives to avoid the doctor.
  - b) The same doctors who are reporting increasing numbers of immigrant cases are reporting the decreasing number of local-born cases.
  - c) It is easier to miss milder indeterminate or tuberculoid cases but, in fact, the proportion of such cases has been rising in the registry, while the number of "easy" BL/L cases is falling.
  - d) Since the DOH now pays private physicians for treating leprosy cases (most insurance plans will not), there is an economic incentive for reporting cases to the DOH.

It seems probable, therefore, that the apparent decline of new Hawaii-born cases is truly happening.
- 2) It may be that resistance to leprosy is improving among Hawaii-born people:
  - a) Centuries of selective social forces in Asia and Europe produced better survival in those who had more resistance to leprosy, and there has been an increasing admixture of Asian and European genes among Hawaiians since the 1860s. While this may be a factor in the fall of leprosy among Hawaiians, it could certainly not have been a factor

among the locally born non-Hawaiians.

- b) More resistance may also be related to improved nutrition, particularly protein nutrition. While there is no direct evidence for this in leprosy, there is very strong experimental evidence in tuberculosis, and circumstantial evidence does support this association in leprosy. In recent years the government has instituted nutrition programs for the poor. These programs have been aimed particularly at children and correspond in time with the rapid fall in number of cases among Hawaii's children.

The recent absolute drop in BL/L cases cannot easily be explained by genetics, since it is apparently taking place simultaneously among both the Hawaiian and non-Hawaiian local-born people. (There have been no new BL/L Hawaii-born, non-Hawaiian cases in the past 14 years). The nutritional hypothesis cannot be lightly dismissed in the face of these events.

A previously published study (7) has shown that a cohort of 203 Hawaiian children in 55 families who had been exposed to an untreated BL/L parent at some time during 1935 to 1953 had had a subsequent leprosy attack rate of 11% during at least ten years of observation. It seems likely from the data presented in Tables 1 and 2 that the analogous attack rate following new adult Hawaiian BL/L cases is probably much lower than 11%. A measurement of the intrafamilial secondary attack rate in Hawaii in recent decades will soon be undertaken.

The recent rise in the number of Hawaii-born, non-Hawaiian cases has contributed to the DOH decision to devote more resources toward improving its community based programs to assure adequate treatment and continuing supervision of all immigrant BL/L cases, who are undoubtedly the source of infection for such secondary cases. A trial is being considered of the use of new serological (1,3) tests for identification of infected contacts of such cases and offering them a course of preventive treatment (5,6), with advice from the WHO Scientific Working Group on Chemotherapy of

Leprosy as to recommended drug regimens. If found effective, this will reduce the already small number of secondary cases appearing in Hawaii.

These measures should assure the final end, within the next decade, of new cases of leprosy among Hawaii-born people, except for an occasional case which will develop in an old person who was infected with *Mycobacterium leprae* years earlier, and in whom the infection has lain dormant until that person's immune defenses decline to the point where the organism can grow. The recent rise in the median age of new Hawaii-born cases is an indication that this process is becoming more visible as the disease disappears among the young. Tuberculosis has followed this pattern for several decades, decreasing in the local population despite continual importation via immigrants.

#### SUMMARY

The 140-year-old epidemic of leprosy among the people of Hawaii reached its peak at about the beginning of this century and has been subsiding ever since. A preliminary review of new cases in Hawaii in the past 15 years showed 49 among those born in Hawaii, plus 360 new immigrant cases (largely from the Philippines and Samoa), 130 of whom were of the borderline lepromatous or lepromatous (BL/L) form. Since 1970 all new cases have been treated as ambulatory patients in their home communities.

A detailed review of all 95 new Hawaii-born cases in the past 21 years showed a continuing rapid decline in incidence among ethnic Hawaiian people, with a fall in the proportion of BL/L cases from its former plateau around 40% to only 20% in the last seven years. The new immigrant BL/L cases have apparently not caused a significant secondary outbreak among the Hawaiians but have caused a modest increase among Hawaii-born members of their own ethnic groups. Among these recent non-Hawaiian secondary cases, the proportion of BL/L cases has also recently dropped so sharply that the risk of significant tertiary spread is minor. The possible role of improved nutrition in Hawaii as an influence on these recent leprosy patterns is suggested.

#### RESUMEN

Los 140 años de epidemia de lepra en la población de Hawaii alcanzaron su pico al principio de este siglo. Desde entonces, el pico epidémico ha venido decayendo. Una revisión preliminar de los casos nuevos en Hawaii en los pasados 15 años reveló 49 casos nacidos en Hawaii y 160 casos entre los inmigrantes (principalmente de Filipinas y Somoa) de los cuales 130 fueron del tipo intermedio-lepromatoso o lepromatoso (BL/L). Desde 1970, todos los casos nuevos han sido tratados como pacientes ambulatorios en sus propias comunidades.

La revisión detallada de los 95 casos nuevos nacidos en Hawaii en los pasados 21 años ha indicado una continua y rápida declinación de la incidencia entre la gente de origen hawaiano, con una caída en la proporción de casos BL/L desde su nivel anterior (de cerca del 40%) a sólo 20% en los últimos 7 años. Los nuevos casos BL/L entre los inmigrantes aparentemente no han causado una expansión secundaria significativa entre los hawaianos aunque sí han causado un moderado incremento entre los miembros de sus propios grupos étnicos nacidos en Hawaii. Entre estos casos secundarios recientes no hawaianos, la proporción de casos BL/L ha caído tan marcadamente que el riesgo de una dispersión terciaria es cada vez menor. Se sugiere la influencia de la mejoría nutricional en Hawaii sobre los patrones recientes de la lepra.

#### RÉSUMÉ

L'épidémie de lèpre notée depuis 140 ans dans la population de Hawaii a atteint son maximum vers le début de ce siècle; elle a diminué depuis lors. Un revue préliminaire des nouveaux cas enregistrés à Hawaii au cours des 15 dernières années a révélé que 49 de ceux-ci étaient nés à Hawaii, et que 360 étaient des cas importés chez de nouveaux immigrants (ceux-ci provenant essentiellement des Philippines et des Samoa); 130 de ces cas importés appartenaient aux formes dimorphe-lépromateuse (BL) ou lépromateuse (L). Depuis 1970, tous les nouveaux cas ont été traité ambulatoirement dans leurs foyers.

Une revue détaillée des 95 nouveaux cas nés à Hawaii au cours des 21 dernières années a révélé un déclin rapide et continu de l'incidence dans la population appartenant ethniquement à Hawaii, avec une réduction de la proportion de cas BL/L, qui a décliné du plateau antérieur se situant à environ 40%, à 20% au cours de ces 7 dernières années. Les cas importés BL/L n'ont apparemment pas entraîné une épidémie secondaire significative parmi les hawaïens, mais ils ont causé une augmentation modérée parmi les personnes appartenant à d'autres groupes ethniques et nées à Hawaii. Parmi ces cas secondaires récents et n'appartenant pas aux groupes ethniques de Hawaii, la proportion des cas BL/L a également présenté une chute tellement rapide au cours de ces dernières années, que le risque d'une dissémination tertiaire significative est tout à fait réduit. On suggère qu'une amélioration de



la nutrition à Hawaii pourrait avoir joué un rôle sur ces récentes tendances de la lèpre dans ce pays.

**Acknowledgments.** We wish to thank the Hawaii Department of Health for access to its records, and we are grateful for the preparation of record abstracts by Dr. Kevin Kunz, Preventive Medicine Resident, Anwei Skinsnes and Jeffrey Bergbauer, students at the University of Hawaii School of Public Health.

We are also grateful to Drs. George Mills and Erida Reichert for their helpful reviews of drafts of this report. Grateful acknowledgment is made of the work of Dr. Reichert, current chief of the Hawaii Hansen's Disease Bureau, in maintaining the case register, and of the work of all those who preceded her in that role in past decades.

### REFERENCES

1. ABE, M., MINAGAWA, F., YOSHINO, Y., OZAWA, T., SAIKAWA, K. and KAITO, T. Fluorescent leprosy antibody absorption (FLA-ABS) test for detecting subclinical infection with *M. leprae*. *Int. J. Lepr.* **48** (1980) 109-119.
2. DEPARTMENT OF HEALTH, Territory of Hawaii, Annual Reports.
3. DOUGLAS, J. T., LEE, J. W., NAKA, S. and BROWN, R. Development of an ELISA for the identification of antibody in leprosy patients (in preparation).
4. MILLS, G. H. Epidemics in Hawaii. *Pacific Health* **14** (1981) 5-7.
5. NOORDEEN, S. K., NEELAN, P. N. and MUNAF, A. Chemoprophylaxis against leprosy with acedapsone. *Lepr. India* **52** (1980) 97-103.
6. RUSSELL, D. A., WORTH, R. M., JANO, B., FASAL, P. and SHEPARD, C. C. Acedapsone in leprosy preventive treatment: Field trial in three high-prevalence villages in Micronesia. *Am. J. Trop. Med. Hyg.* **28** (1979) 559-563.
7. WORTH, R. M. and HIRSCHY, I. D. A test of the infectivity of tuberculoid leprosy. *Hawaii Med. J.* **24** (1964) 116-119.
8. WORTH, R. M. The disappearance of leprosy in a semi-isolated population (Niihau Island, Hawaii). *Int. J. Lepr.* **31** (1963) 34-45.

### Appendix

#### ESTIMATION OF SAVINGS DUE TO POLICY CHANGE

During the two decades before the Hawaii Department of Health policy change in

1970 the average duration of isolation of BL/L patients under sulfone therapy was about seven years.<sup>1</sup> The recent average incidence of such cases has been about 8.5 per year. The epidemiologic formula for estimating prevalence where incidence is fairly steady is:<sup>2</sup>

$$\frac{\text{Incidence}}{8.5 \text{ cases/yr}} \times \frac{\text{Duration}}{7 \text{ years}} = \frac{\text{Prevalence}}{60 \text{ people isolated}}$$

To these 60 people one could add another two or three isolated due to relapse. This estimate comes close to the actual drop of about 65 institutionalized cases which actually occurred shortly after the policy change.

These 63 people  $\times$  365 days = about 23,000 person-days of isolation per year. Aside from humanitarian or civil rights considerations, one might estimate the cost of that isolation. Using the Department of Social Services rate of \$12 per boarding home day as a minimum, multiplication by 23,000 person-days results in an annual direct cost of at least \$276,000 per year. To this would have to be added another \$36,000 for total nonleprosy related medical care costs (policy for in-patients), less about \$48,000 for current leprosy-related costs per year for 63 BL/L ambulatory patients. An additional amount would have to be added for the welfare costs of supporting those families made destitute by the isolation of a breadwinner. This would give a total savings in the neighborhood of \$300,000 per year.

<sup>1</sup> Gould, K. I. Leprosy and public health in Hawaii: Changing a policy of isolation. *Hawaii Med. J.* **28** (1969) 365-373. (An upward adjustment of 0.6 years has been made to account for biases in case selection of this paper.)

<sup>2</sup> Mausner, J. S. and Bahn, A. K. *Epidemiology—An Introductory Text*. Philadelphia, Pennsylvania: W. B. Saunders Company, 1974, p. 127.