INTERNATIONAL JOURNAL OF LEPROSY
and Other Mycobacterial Diseases
OFFICIAL ORGAN OF THE INTERNATIONAL LEPROSY ASSOCIATION
Publication Office: Leahi Hospital, 3675 Kilauea Avenue,
Honolulu, Hi. 96816

VOLUME 43, NUMBER 2 APRIL-JUNE 1975

EDITORIALS

Editorials are written by members of the Editorial Board, and occasionally by guest editorial writers at the invitation of the Editor, and opinions expressed are those of the writers.

Immuno-Epidemiology of Leprosy

The only epidemic of leprosy that has been reported *de novo* is that which occurred on Nauru ([2, 3, 7, 8, 9]).

Leprosy epidemic at Nauru. This epidemic can be briefly summarized:

8.4 sq mi coral atoll; 1.8 sq mi inhabitable. Population 1,200-1,500.

Chief product—phosphate rock from guano deposits.

c. 1912—Etsio, a Gilbertese female with leprosy arrived. Resident M.O. protested landing; overruled by governor. Etsio lived near Demau, a 13 year old Nauruan girl.

1920—Demau diagnosed as having leprosy. Others also. Influenza killed 30% Nauruans, including all, save Demau, having diagnosed leprosy.

1922—12.5% with leprosy; 1924—23.7%.

By 1929 a total of 438 cases, 35% of population.

1939—8% with leprosy.

1943—all leprosy inpatients towed away in a leaky boat and reportedly destroyed by gunfire.

1948—sulfone treatment introduced.

1950—4.3% with leprosy.

This extremely high disease prevalence, particularly for a chronic disease with a pathogen of low virulence, becomes understandable when it is recognized that the majority of the instances reported were apparently mild, tuberculoid or near tuberculoid cases. Coupled with Leiker's studies in Irian (W. New Guinea), it provides a reasonable understanding of the reflection of the leprosy immunologic spectrum as the disease intrudes into a leprosy virgin society. Leiker ([5]) compared the disease pattern in endemic coastal villages with the pattern of more recently developing disease in inland villages to which it had spread from the coastal areas. His findings, summarized in the following table, are worth cogitation.

It becomes evident that when leprosy is freshly introduced into a previously unexposed community or society, those infected include that segment of the exposed population which has low inherent resistance to the infection as well as a proportion of the community which has the potential for developing high resistance or immunity to the pathogen. The number of cases at or near the tuberculoid end of the spectrum is high. As

TABLE 1. *Contrasting epidemiologic patterns in leprosy.*

Epidemic pattern of leprosy in a leprosy virgin population	Epidemic pattern of leprosy in endemic foci
1. The disease spreads rapidly after its introduction.	1. The infection spreads slowly.
2. Cases are found in the majority of houses in the village, and foci seem to be of minor importance.	2. Foci persist, even after a long endemic history, and there are families and villages with a significantly higher leprosy index than others in the area.
3. The type index is very low so that there is almost an epidemic of tuberculoid leprosy and cases predominate which have only one or a few macules.	3. The type index is variable, but seldom lower than 20-25%, and often higher (i.e., the proportion of lepromatous leprosy).
4. Adults are almost as susceptible as children.	4. A relatively high proportion of cases is found among children and young adults.
5. Most cases have not had contact with lepromatous cases, and even in those that have there has not been prolonged, intimate house contact.	5. Contact with lepromatous leprosy is evident in a high percentage of new cases. This contact often consists of prolonged, intimate house contact and often family contact.

the infection becomes endemic, these individuals, having overcome their first mild infection are, in the majority, immune to the prevailing challenge dose. Those initially developing lepromatous leprosy smolder on and are joined by others of low resistance who meet an adequate challenge dose. The pattern thus changes, except in the child segment of the population, for this is a constantly replenished leprosy virgin population and repeats, with perhaps slight modification, the characteristic disease pattern of such a population. Thus, Lara and Nolasco (4), in a study of children born at Culion leprosarium in the Philippines over a 24-year period, found that about 80% of those that developed leprosy contracted the mild infections which healed spontaneously and about 88% of these healed cases occurred without residual stigmata. They reasoned that probably the same pattern occurred in the general population of children affected by leprosy and that the residual 20% represented the spectrum of children with leprosy commonly admitted to leprosaria.

Several pertinent conclusions develop from these epidemiologic observations:

1. Because of the uneven "pocket" distribution of cases in an endemic area, preventive measures need not be equally pursued in all villages of an endemic area but should rather be contact case oriented.
2. For the same reason it is not accurate to take a local high prevalence rate and by multiplying this into a large area, or national, population census attempt to achieve an estimate of the total leprosy problem of that region. Such an attempt was recently noted in a publication relating to leprosy in Taiwan. The estimated number of cases was given as 45,000, a figure apparently arrived at by multiplying the highest incidence figure from the Pescadore Islands, into the total population without regard to the findings from the rest of Taiwan. In previous estimates from several sources over the past 30 years the highest has been 10,000 cases.
3. Case finding by school and mass surveys is expensive and far less rewarding than pursuit of case contacts.

The extent of the world leprosy problem is based largely on "guess-timates" and is usually given as approximately 15 million cases. This figure correlates reasonably well with given prevalence rates as related to population figures, but these are also estimates established largely without reference to some of the epidemiologic principles noted, simply because information from most areas where leprosy is prevalent is inadequate. Thus, mainland China is given as having 2 to 4.9 cases per 1,000 population but it is well known that the prevalence rates in Central and North China are vastly different from those of South and Southwest China. Recent personal information from China indicates that all known leprosy cases are

centrally registered and that the prevalence rate is generally considerably less than has been previously thought.

The effect of chemotherapeutic segregation on endemic leprosy patterns. Chemotherapy for leprosy has now been available to most leprosy endemic areas for 25 to 30 years and, using the yearly incidence of new cases in some of these areas as an index of leprosy control, its effect on endemic leprosy can be compared with the effect that virtually total mandatory physical segregation had on the 19th century epidemic in Norway.

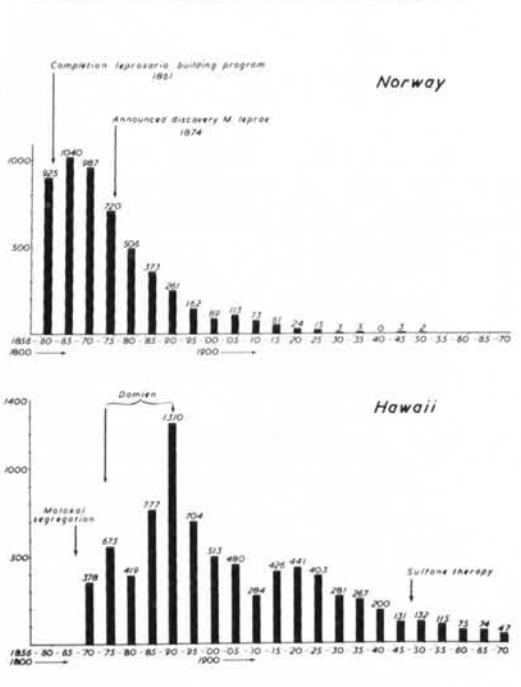


Figure 1 graphs, by five year interval totals, the pattern of new cases in that epidemic ([6]) in comparison with the Hawaiian epidemic. Figure 2 presents similar graphs for new cases in Taiwan and Hong Kong. These and similar graphs of the Asian areas such as Japan and Okinawa indicate that the peak of new case appearance is, of course, not a true determination of new cases then developing but reflects some intensified leprosy related effort, such as case finding or developing treatment centers which bring forth a large number of hidden cases. Following such a peak, the slopes of the graphs are remarkably similar and resemble that of the Norwegian graph so well that the latter may serve as a guide for predicting the general length of time it will take to reduce leprosy to a minor problem in each of these areas. The Norwegian epidemic required essentially 12 pentads for virtual eradication after its peak. The Hawaiian has simmered for 17 pentads, six of which have been in the sulfone era, but it has been continuously fed by immigration, most recently from Samoa and the Philippines. Its "indigenous" epidemic can be considered as being virtually over 14 pentads after its peak, having been treated initially by rigid physical segregation, then by a combination of segregation and chemotherapy and, as of 1974, by chemotherapy without segregation.

The Hong Kong experience, like the Hawaiian, is fed by immigration of new cases. It has been countered by chemotherapy and outpatient treatment primarily, but backed up by voluntary hospitalization and the same has been true for the Taiwan endemic with the difference that for the past 25 years, for which figures are available, there has been virtually no influencing immigration. In Hawaii and Japan virtually all leprosy cases have come under treatment, whereas in Hong Kong and Taiwan from one-third to one-half have received treatment. Despite these differences, the drop in incidence of new cases has been remarkably similar and of a like pattern to that of the Norwegian experience. It may be tentatively suggested that:

1. Chemotherapeutic segregation, even when applied to only about one-third of an endemic leprosy population in areas of concomitantly developing economic advance, is as effective in reducing the incidence of new cases as is to-

2. Barring retrogressive social change, such as war or widespread famine or malnutrition, an indigenous leprosy endemic, in an area of rapidly rising standards of living, which is not continually replenished by immigration is likely to recede to virtual insignificance within fifty years even if chemotherapeutic segregation is available to less than 50% of indigenous cases.
3. In a limited, relatively isolated population such as a Pacific isle, total prophylactic treatment may stop the development of new cases within a few years, but this is hardly practical for large population masses.
4. It is evident that powerful factors other than physical or chemotherapeutic segregation are operative in the eradication of endemic leprosy.

The endemics here discussed have three major factors in common:

1. They involved Oriental and Caucasoid populations, these being racially more susceptible.
2. In all instances the leprosy prevalence fell within the range of 2 to 4.9 per 1,000 ([1]) or less.
3. The endemic subsidence coincided with rapid economic development in the countries concerned.

Whether or not the principles and trends here noted are applicable to other population groups, such as those of Africa, in which leprosy prevalence rates may, in some instances, be upwards of 40 per 1,000 ([1]), is a question that lies beyond the purview, resources and experiences of this reviewer. It would seem likely that though the magnitude of the problem may change the time scale, the general pattern is probably similar.

The economic advances with improved standards of living would seem to be of equal significance to chemotherapy in the subsidence of an endemic, at least in relation to the present standard of achievement in making chemotherapy available. In all probability this was a major cause of the virtual disappearance of leprosy from much of Europe in the Middle Ages before effective chemotherapy was available.

It is not improbable, academically speaking, that in time leprosy might virtually disappear from the world without chemotherapeutic segregation as each geographic area witnessed the hoped for improvements in standards of living, but this would take an unknown period of time.

A striking difference between physical segregation and chemotherapeutic segregation is that the former permits the disease to continue its devastating role in the life of the afflicted whereas the latter aborts this process and for many can avert the otherwise expected crippling and devastation. In the endemic areas above referred to, it is remarkable how rapidly the appearance of florid lepromatous leprosy declined and was replaced by the emergence of early case applications for treatment once sulfone therapy became available. In this there lies great hope for future avoidance of the great backlog of crippled and devastated patients that are seen in each of these societies and that require society's supportive care for a quarter to half a century. This realization alone calls for the widest possible dissemination and application of presently available therapeutic measures.

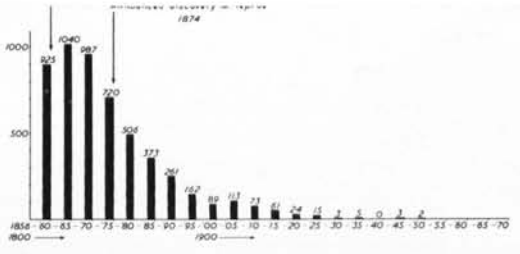
OLAF K. SKINSNES

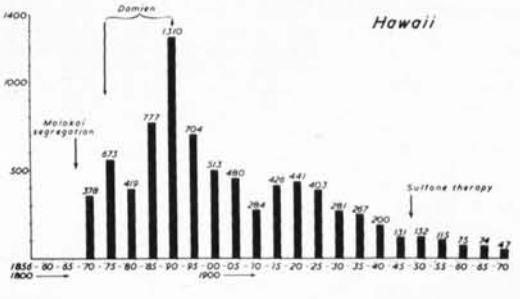
REFERENCES

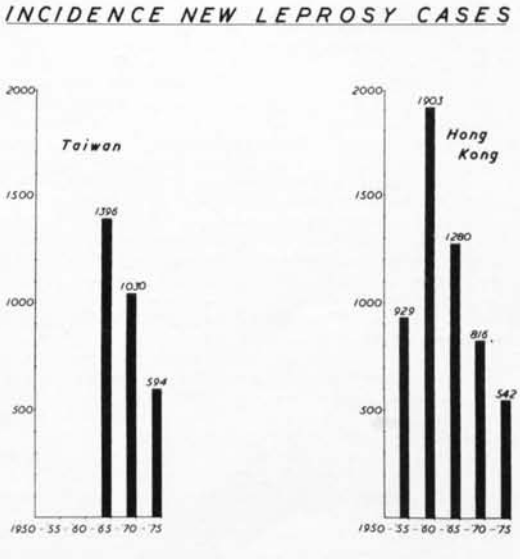
1. BECHELLI, L. M. and MARTINEZ DOMINGUEZ, V. The leprosy problem in the world. Bull. WHO **34** (1966) 811-826.
2. BRAY, G. W. The story of leprosy at Nauru. Int. J. Lepr. **2** (1934) 319-323.
3. GRANT, A. M. B. Leprosy at Nauru since 1928. Int. J. Lepr. **2** (1934) 305-310.
4. LARA, C. B. and NOLASCO, J. O. Self-healing, or abortive, and residual forms of childhood leprosy and their probable significance. Int. J. Lepr. **24** (1956) 245-263.
5. LEIKER, D. Epidemiological and immunological surveys in Netherlands New Guinea. Lepr. Rev. **31** (1960) 241-259.
6. MELSON, R. Spedalskhetens historie i Norden. Ciba Tidskrift **29** (1952) 952-959.
7. NEWS AND NOTES. The present status of leprosy on Nauru. Int. J. Lepr. **16** (1948) 491.
8. WADE, H. W. The Nauru epidemic. Int. J. Lepr. **2** (1934) 359-362.
9. WADE, H. W. and LEDOWSKY, V. The leprosy epidemic at Nauru. Int. J. Lepr. **20** (1952) 1-29.

ADDENDUM: The following is to be added to IJL, Volume 43, Number 2, April-June 1975, p 147. The last sentence at the bottom of right column is to read as follows: "1. Chemotherapeutic segregation, even when applied to only about one-third of an endemic leprosy population in areas of concomitantly developing economic advance, is as effective in reducing the incidence of new cases as is total physical segregation."

year interval totals, in that epidemic (6) Hawaiian epidemic. lar graphs for new ng Kong. These and Asian areas such as cate that the peak of of course, not a true ses then developing ified leprosy related ding or developing bring forth a large s. Following such a graphs are remarke that of the Norwethe latter may serve g the general length luce leprosy to a minor problem in each of these areas. The Norwegian epidemic required essentially 12 pentads for virtual eradication after its peak. The Hawaiian has simmered for 17 pentads, six of which have been in the sulfone era, but it has been continuously fed by immigration, most recently from Samoa and the Philippines. Its "indigenous" epidemic can be considered as being virtually over 14 pentads after its peak, having been treated initially by rigid physical segregation, then by a combination of segregation and chemotherapy and, as of 1974, by chemotherapy without segregation.







The Hong Kong experience, like the Hawaiian, is fed by immigration of new cases. It has been countered by chemotherapy and outpatient treatment primarily, but backed up by voluntary hospitalization and the same has been true for the Taiwan endemic with the difference that for the past 25 years, for which figures are available, there has been virtually no influencing immigration. In Hawaii and Japan virtually all leprosy cases have come under treatment, whereas in Hong Kong and Taiwan from one-third to one-half have received treatment. Despite these differences, the drop in incidence of new cases has been remarkably similar and of a like pattern to that of the Norwegian experience. It may be tentatively suggested that:

1. Chemotherapeutic segregation, even when applied to only about one-third of an endemic leprosy population in areas of concomitantly developing economic advance, is as effective in reducing the incidence of new cases as is to-