Immigration of Ethiopians with Typhoid Fever to Israel: Apparent Lack of Influence on the Local Population

Yehuda Carmeli,* Jonathan M. Schapiro,† and Michael Alkan

From the Infectious Disease Institute, Soroka Medical Center and Faculty of Health Sciences, Ben Gurion University of Negev, Beer Sheva, Israel

The epidemiology of typhoid fever in Western countries may be affected by immigration from developing countries. We studied the immigration of Ethiopian Jews to Israel to find the effects of an influx of many individuals infected with typhoid into an area with a low incidence of the disease. Typhoid fever affected 204 Israelis and 121 (1.1%) of 10,654 Ethiopian immigrants during the period of 1984–1985. Of those Ethiopian cases, 107 occurred during a 3-month period. During the 5 months following that 3-month period, there was no increase in the number of cases of typhoid among Israelis. Although after that time there was a local waterborne outbreak of typhoid that affected 83 Israelis, no Ethiopians resided in the area where the outbreak occurred; therefore, we concluded that these 83 cases of typhoid fever were not related to the immigration of Ethiopians into Israel. In fact, if those 83 cases were excluded from the statistical analysis, there was no increase in the occurrence of typhoid during the 2-year period studied. Therefore, the immigration of many people with typhoid into an area of low incidence does not necessarily confer a risk of infection to the local population.

The incidence of typhoid fever can be controlled by limiting the fecal-oral spread of the causative organism. Many Western countries have achieved a low incidence of the disease by developing adequate systems for fecal elimination. Nevertheless, the disease continues to be a major international health problem, and it is estimated that 12 million new cases occur annually, mostly in developing countries. In Western countries, epidemics of typhoid fever are uncommon and most infections are acquired during foreign travel [1]. In areas with a low incidence of disease, host resistance tends to be low; therefore, the potential for large-scale epidemics exists. Indeed, epidemics occur occasionally when food is infected or when water sources are contaminated. Because the reservoir of typhoid (humans) is small in Western countries, immigrants from developing countries are often the source of the disease [2–5].

During 1981–1983, the incidence of typhoid fever in Israel ranged between one and two cases per 100,000 population per year [6]. In the years 1984–1985, there was a huge wave of immigration of Ethiopian Jews to Israel; many of these immigrants were found to have typhoid fever, which they contracted in Africa [7]. We have evaluated this immigration to determine the consequences of the immigration of a relatively large number of infected persons into an area with a low incidence of the disease.

Patients and Methods

Many Ethiopian Jews immigrated to Israel after the famine in Ethiopia in 1984. Upon arrival, they were housed in absorption centers, where they resided for a few months; during their stay their material needs were met by governmental agencies. The absorption centers were hotels and the immigrants were not quarantined, nor were they employed during this time. Data regarding the Ethiopian immigrants, the Israeli population, and morbidity rates were collected from the monthly reports of the Central Bureau of Statistics (Jerusalem, Israel) [6, 8]. We collected data on typhoid fever morbidity and Salmonella typhi phage types from the reports of the Ministry of Health Central Laboratory (Tel Aviv, Israel). All cultures that yielded S. typhi were sent to the Central Laboratory for bacteriophage typing [9]. Data concerning chronic carriers of typhoid were excluded from the study. Data were broken down by country of origin to distinguish between Ethiopians and Israelis [7]. Statistical analysis was performed using $\chi^2$ analysis for two-by-two tables.

Results

In the years 1984–1985, 10,654 Ethiopian Jews immigrated to Israel: 7,307 (68%) of them immigrated during the period from November 1984 through January 1985. In those 2 years, 325 cases of typhoid were recorded (121 Ethiopians and 204 Israelis). When we compare the different periods of

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* Current address: Division of Infectious Diseases, New England Deaconess Hospital, Boston, Massachusetts.
† Current address: Center for AIDS Research, Stanford University Medical School, Stanford, California.
Reprints: Dr. Yehuda Carmeli, Division of Infectious Diseases, New England Deaconess Hospital, 85 Pilgrim Road, Boston, Massachusetts 02215.
Correspondence: Dr. Yehuda Carmeli, 77 Trowbridge Street, No. 43, Cambridge, Massachusetts 02138.
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immigration and the number of cases of typhoid by the individual's country of origin, we find that most of the cases among Ethiopians occurred after the period of immigration from November 1984 through January 1985 (figure 1, B and C). Indeed, 107 of the 121 cases of typhoid among Ethiopians occurred during the 3-month period of December 1984 through February 1985, which represented a morbidity rate of 1.5% for that period. This rate is significantly higher ($P < 0.001$) than that for the remainder of the immigration period (0.4%). The Ethiopians with typhoid were located throughout Israel (data not shown). The causative organisms were of several phage types: 57 cases were due to type C1; 14, to type E1: 13, to phage type 46: 8, to type A: 3, to type D2: and 1, to type E2. Seven organisms were not typable and four were degraded.

There was a high incidence of typhoid among Israelis during the period from August through October 1985. Data were broken down by phage types (figure 1, A), and the organism causing the highest rate of morbidity was found to be phage type C1. We further evaluated the data by geographical area. We found that 83 of the 204 cases among Israelis during the period from August through October 1985 were restricted to northern Israel: all 83 cases were due to S. typhi phage type C1. None of the patients affected by this epi-

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**Figure 1.** The number of cases of typhoid caused by *Salmonella typhi* phage type C1 vs. all other *S. typhi* phage types (A), the number of patients with typhoid according to country of origin (B), and the distributions in the number of Ethiopians immigrating to Israel in 1984-1985 (C).
The epidemic among Ethiopians in Israel subsided in February 1985; any other local cases resulting from this typhoid to an area with a low incidence of the disease would have been expected to arise within one period of incubation (2-3 weeks) [10]. During this period, however, the incidence of typhoid among Israelis did not increase. A secondary epidemic was probably prevented by the following factors: patients with typhoid fever were hospitalized during the early stages of the disease [7], none of the Ethiopian immigrants worked as food handlers (which could have initiated a food-borne outbreak) [2-4], and Israel has modern sanitation practices that protect the drinking water from contamination. Five months after the typhoid outbreak among Ethiopian immigrants subsided, there was another outbreak, which was restricted to a small area in northern Israel. It was caused by \textit{S. typhi} phage type C1, the causative organism for most of the cases among Ethiopians; the last case of typhoid among Ethiopians that was caused by phage type C1 occurred in April 1985, three months before the outbreak in northern Israel.

Two weeks before the outbreak of typhoid in northern Israel, there was a shigellosis epidemic that affected approximately 10,000 individuals in the same northern area. Investigation by the local health service revealed the cause to be contamination of the water supply by sewage from the town of Shfaram [11]. Shfaram is an Arab town in which no Jewish people and no Ethiopian immigrants reside, and it is known to be endemic for typhoid fever caused by \textit{S. typhi} phage type C1 [12].

There were many factors that suggested that the epidemic in northern Israel was not associated with immigration of Ethiopians with typhoid: the lag time of more than four average incubation periods between the last case of typhoid due to phage type C1 among Ethiopians and the epidemic in northern Israel; the fact that another source of infection was found (contaminated water); and the fact that no Ethiopian immigrants lived in the region that was the source of the contaminated water supply.

The incidence of typhoid among Israelis (excluding the epidemic in northern Israel) was 1.4 per 100,000 population per year (1984-1985), which is in the same range of that reported for the previous 3 years and the following 3 years [6]. Therefore, we conclude that the importation of typhoid fever by Ethiopian immigrants did not influence the rate of morbidity among Israelis. The results of our investigation suggest that an increase in the reservoir of \textit{S. typhi} in an area where the population has low resistance does not necessarily increase local morbidity rates. This, of course, presupposes that the supply of drinking water is protected from contamination, that individuals with typhoid are hospitalized during the early stages of the disease, and that patients actively ill with typhoid and chronic carriers of the disease are prevented from working as food handlers.

**References**