

Infant Botulism in the United States: An Epidemiologic Study of Cases Occurring Outside of California

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Abstract: Data were obtained for the 96 hospitalized cases of infant botulism reported to the Centers for Disease Control between 1976–1980 from all states other than California. Forty-one cases were associated with *Clostridium botulinum* type A, 53 with type B, one with type F, and one with a strain of *C. botulinum* capable of producing both type B and F toxin. Cases occurred in 25 states; the disease was more common in the western part of the United States, with the highest attack rates reported for Utah and New Mexico.

Birth-weights of hospitalized infants with infant botulism tended to be high compared with birth-weights in the United States population. Mothers of infants with infant botulism tended to be older and better educated than mothers in the general population. Seventy per cent of infants had been predominantly breast-fed; breast-feeding in type B cases was associated with a significantly older age at onset of illness. (*Am J Public Health* 1983; 73:1385–1388.)

Introduction

Infant botulism was first recognized as a distinct clinical entity in 1976.^{1,2} Unlike foodborne botulism, which is caused by ingestion of pre-formed botulinum toxin, infant botulism is associated with infection of an infant's intestinal tract with *Clostridium botulinum*, with subsequent *in vivo* toxin production and absorption.^{3,4} The resulting clinical syndrome has been well described: patients have a descending pattern of flaccid paralysis, usually preceded by constipation, and accompanied by lethargy and a weak suck and cry.^{3,5–8} Almost all cases occur in infants under the age of 6 months.^{6,7} California studies have shown that there may be an increased risk of illness associated with feeding infants honey,⁹ and it has been suggested that other feeding practices (such as breastfeeding) may influence the development and severity of the disease.¹⁰ Environmental factors, such as rainfall, have also been identified as possible risk factors.¹¹

At the Centers for Disease Control (CDC) we have collected epidemiologic data on infant botulism since 1976. In this study, we present a summary of our data on all hospitalized cases occurring between 1976–1980 reported from states other than California; California data have been collected and analyzed separately in a series of studies conducted by the California Department of Health Services.^{2–7,9–10,12–13}

Materials and Methods

A total of 96 cases were reported to CDC by local and state health departments (other than California) between 1976–1980. In all cases, patients were hospitalized, were less than one year of age, had some element of acute neurologic dysfunction, and had botulinum toxin or *C. botulinum* organisms in their feces. Eighty-eight hospitalized cases reported

by California in this time period are not included in our analysis.

Toxin type, age at onset (defined as the age at which the infant was first seen by a physician), and sex were known in all 96 cases. Additional clinical and epidemiologic data, including data on feeding, were obtained using a specialized surveillance questionnaire, completed by health department or CDC personnel at the time of the patient's illness. Feeding history was recorded for the period "prior to onset of present illness." Formula and breast feeding were recorded as "ever breast-fed" or "ever bottle-fed", with a subsequent question asking whether the child was >50 per cent breast-fed, >50 per cent bottle-fed, or fed both equally. Questionnaires were filled out (with varying degrees of completeness) for 88 (92 per cent) of the 96 cases.

Population data are based on statistics for live births from the National Center for Health Statistics.^{14–18} Unless otherwise specified, data given for White infants includes both "White, not Hispanic" and "Hispanic" ethnicity categories. Study and population data were compared using a cumulative binomial distribution.

Results

In 1976, the first year in which the disease was described, three cases of infant botulism occurring outside of California were reported to CDC; in 1980, 36 such cases were identified (Figure 1). Cases of infant botulism were reported by 26 states between 1976–1980 (Figure 2). The disease was identified more frequently in the western part of the United States, with the highest attack rates observed in Utah and New Mexico. In 29 cases patients lived in one of five metropolitan counties (Montgomery and Delaware Counties in Pennsylvania, Salt Lake and Davis Counties in Utah, or Maricopa County in Arizona).

Forty-one cases were due to *C. botulinum* type A and 53 to type B. *C. botulinum* type F was identified in one case, and in one case a strain of *C. botulinum* capable of producing both type B and F toxin (B/F) was identified. Forty (98 per cent) of the 41 type A cases and 14 (26 per cent) of the 53 type B cases occurred in states located west of the Mississippi; the type F and B/F cases both occurred in New Mexico. Type A cases occurred more frequently between April and June in the mountain states (14 of 27 cases), and between October and December in the Pacific Northwest (six of 11

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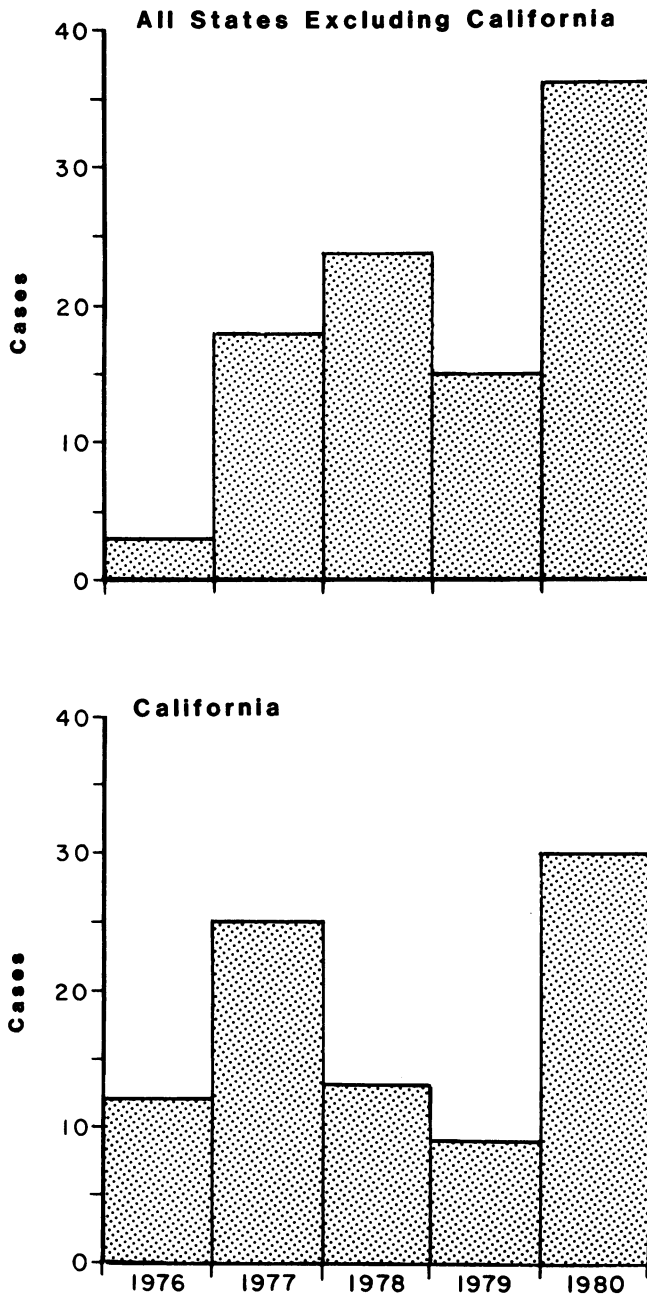


FIGURE 1—Hospitalized Cases of Infant Botulism Reported to CDC, 1976–1980

cases). Type B cases did not demonstrate any clear seasonal pattern.

The median age at onset of illness for infants with infant botulism was 12 weeks. The age at onset in type A and B cases did not differ significantly; there was, however, a difference in the age distribution curves, with type A cases occurring more frequently at age 8–11 weeks, and type B cases at age 16–19 weeks (Figure 3). The onset of illness in the type F case occurred at age two weeks, and in the type B/F case at five weeks. Forty-seven (49 per cent) of the infants were female.

Seventy-seven (92 per cent) of 84 infants for whom data on race were available were White, not Hispanic, three (3.6

per cent) were Black, and two (2.4 per cent) were Hispanic. One case occurred in an Asian infant and one in an American Indian. Fifty-eight (69 per cent) of 84 infants for whom data were available lived within standard metropolitan statistical areas (SMSAs); only 12 (14 per cent) lived within cities with a population of greater than 100,000. Although these relative percentages differ from those for total US live births, the differences were not statistically significant when data were stratified by state of residence.

The median birth weight of infants with infant botulism was 3519 grams. Only 3 (4 per cent) of the 72 White infants for whom data were available weighed ≤ 2500 grams; 24 per cent weighed >4000 grams, compared to 11 per cent of White US live births ($p < .001$). Seventy-one per cent of White mothers of infants with infant botulism were age 25 years or older, compared to 51 per cent of White mothers in the general population ($p < .001$); when mother's age was stratified by birth order, young mothers (<25 years) with their first or second child were significantly underrepresented (21 per cent of White cases vs 44 per cent of White US births, $p < .0001$). Parents also tended to be well educated: among White parents, 59 per cent of mothers and 70 per cent of fathers had 14 or more years of education, compared to 24 per cent of mothers ($p < .0001$) and 36 per cent of fathers ($p < .0001$) in the general population. These differences remained statistically significant when data were stratified by state.

Fifty-eight (70 per cent) of the 83 infants for whom feeding data were available were predominantly ($>50\%$) breast-fed, with 33 per cent never having received bottle feedings. When stratified by educational level, 17 (57 per cent) of 30 infants whose mothers had <14 years of education were predominantly breast-fed; 33 (79 per cent) of 42 infants whose mothers had ≥ 14 years of education were predominantly breast-fed. There were no significant differences in the relative frequency of breast-feeding versus bottle-feeding when data were stratified by toxin type, mother's age, or infant's birth order. In 22 cases (10 type A cases and 12 type B cases—27 per cent of cases for which data were available), infants had been given honey before they became ill. These 22 cases were reported from 11 states, with Utah reporting nine of the 22. A wide variety of other foods had been fed to infants prior to onset of illness; the more common food groups included cereal (46 per cent of infants), syrup (35 per cent), canned baby foods (28 per cent), and fruit juices (22 per cent). There were no significant differences in patterns of feeding for any of the infant foods by toxin type, or by any of the demographic characteristics recorded.

In type B cases in which infants were predominantly bottle-fed, the median age at onset of illness was 66 days, compared with a median of 116 days for patients who were predominantly breast-fed; age at onset was significantly greater for patients predominantly breast-fed compared with those predominantly bottle-fed ($p = .015$, Mann Whitney U Test). Age at onset did not differ significantly by breast-feeding versus bottle-feeding for type A cases, nor, using a multiple regression technique, did it differ for either toxin type for any of the other infant foods on which data were obtained.

Discussion

The data included in this analysis have several major limitations. As we were dealing with a "new" disease,

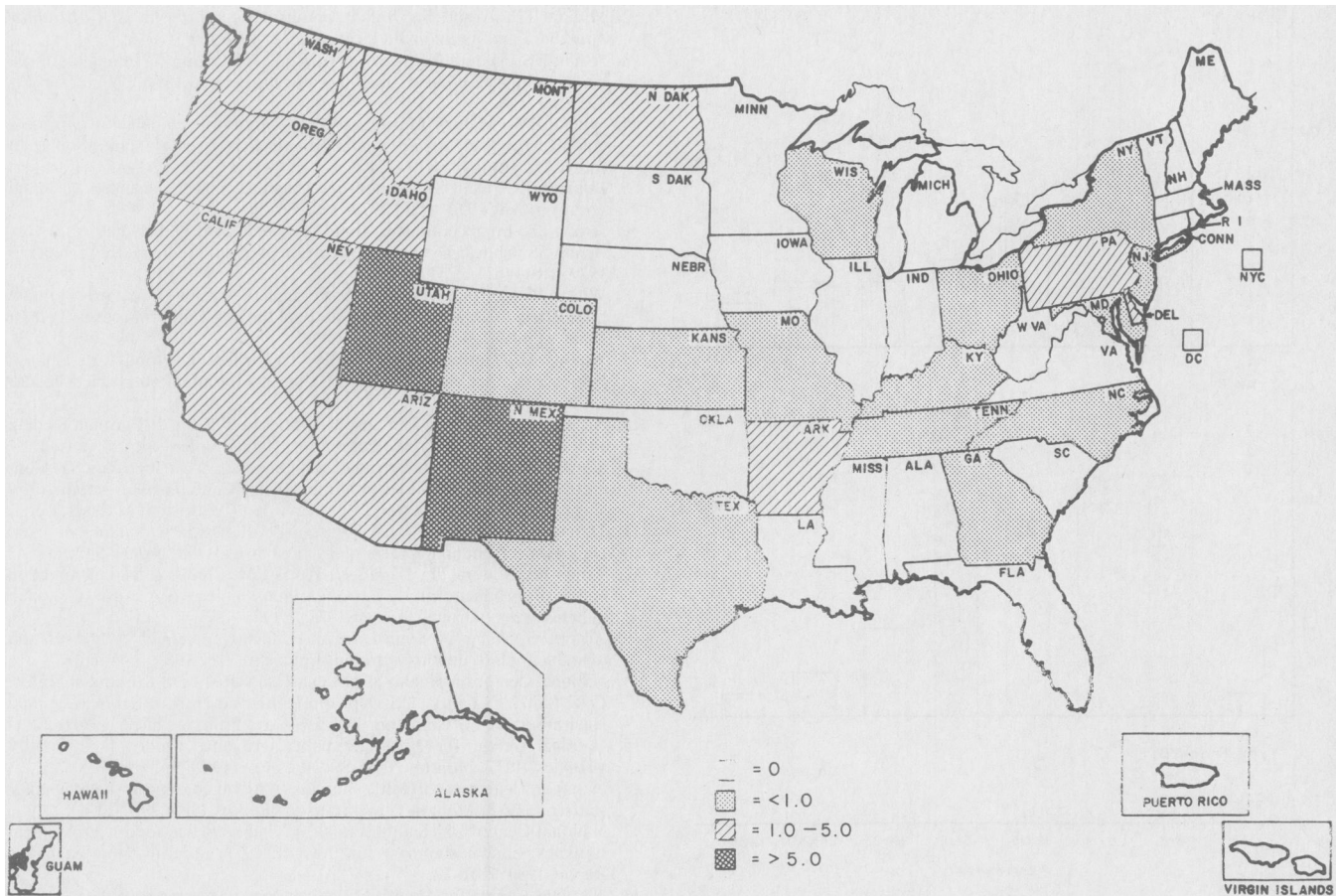


FIGURE 2—Number of Cases of Infant Botulism Reported to CDC, per 100,000 Live Births, by State, 1976–1980

overall case recognition undoubtedly was poor, particularly for the first few years of our study; as a consequence, absolute values such as those given for attack rates have little meaning except for comparisons within the study. Similarly, by only including hospitalized patients, we have restricted ourselves to a single part of the spectrum of disease which may be associated with infant botulism: other studies have suggested that patients may often have only mild symptoms, not requiring hospitalization,^{7,11} or, at the other end of the disease spectrum, have a fulminant illness diagnosed as Sudden Infant Death Syndrome (SIDS).^{7,12,13}

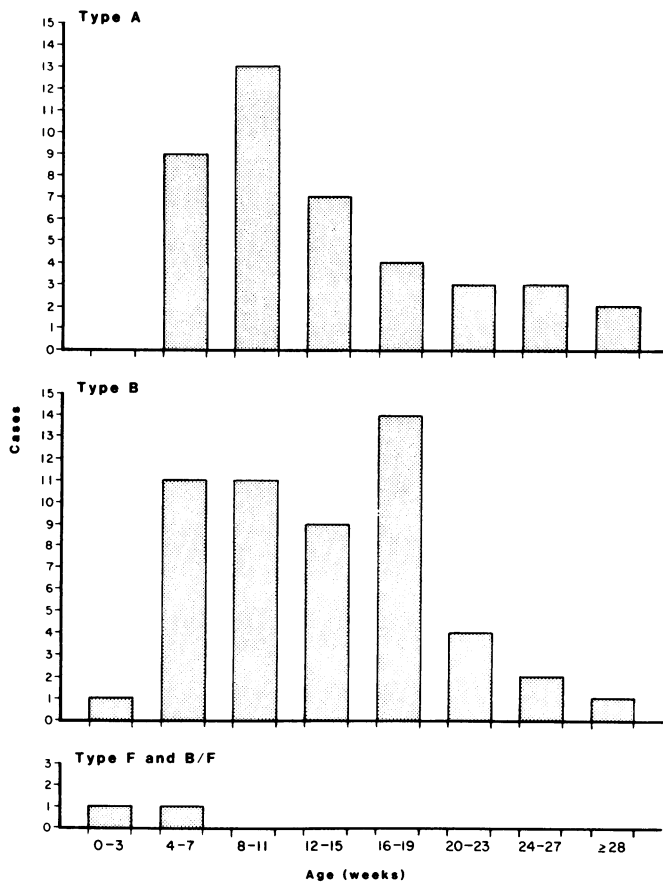
Our data do suggest that among hospitalized patients there are geographic differences in disease incidence, with higher attack rates present in the west and the middle Atlantic states. The unusually high incidence noted in a few counties in Pennsylvania, Utah, and Arizona may have been influenced by local interest and experience with the disease, with associated improvement in case recognition. It is difficult to attribute all of the observed variability in incidence to differences in recognition, however: the disease is distinctive (with laboratory confirmation of the diagnosis available in all states through the state health department laboratory or CDC), received wide publicity, and, as our data demonstrate, was recognized in 25 states over a relatively short period of time.

There were distinct differences in the geographic distribution of cases by toxin type. Type A cases occurred almost exclusively in western states; type B cases tended to occur

predominantly in the east. This pattern closely parallels that of botulinal spores in the environment¹⁹ and, to a lesser degree, the pattern seen among adult botulism cases. Type B cases tended to be much more common in infant botulism, however, accounting for 55 per cent of our cases but only 24 per cent of adult foodborne botulism outbreaks reported to CDC during the past 30 years.²⁰ Other differences in the epidemiology of the two toxin types are also apparent from our data: type A infant botulism cases demonstrated some evidence of seasonality, onset of type B cases differed based on feeding practices, and there were differences in the age distribution curves of type A and B cases.

The infants with botulism included in this study had relatively high birth-weights, suggesting that susceptibility was not associated with prematurity. Our data further suggest that infant botulism (at least among hospitalized patients) was in many ways a "suburban" disease—occurring in infants born as the third or fourth child to well educated, somewhat older parents, living within SMSAs but outside of the city limits of large cities. Again, it is possible that this was in part a reporting artifact, with these infants having a greater likelihood of reaching medical facilities where the diagnosis would be made. It should be noted that these demographic characteristics differ markedly from those described for SIDS infants, who tend to be Black,^{21,22} with low birth weights,²²⁻²⁴ and with younger, more poorly educated mothers.^{22,24} living in large cities.²¹

In the absence of a control group it is difficult to



* Hospitalized cases, excludes California

FIGURE 3—Age Distribution of Infant Botulism Cases* Reported to CDC, by Toxin Type, 1976-1980

evaluate our data on feeding. In a recent study by Martinez, 52 per cent of two-month-old infants of college educated mothers were breast-fed, as were 28.5 per cent of infants of grade school and high school educated mothers.²⁵ While not directly comparable with our data, these values do suggest (in agreement with Arnon's case-control studies in California)^{10,13} that breast-feeding is more common among hospitalized infant botulism patients than among infants in the general population. As with other observations, further studies (with appropriate control groups) will be needed to fully evaluate these results.

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