# Human Brucellosis in Indiana, 1946–50

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THROUGH cooperative projects between national and State agencies, various aspects of brucellosis were investigated in Indiana during the 5-year period 1946–50. Because the data provide detailed information concerning the largest population groups at risk during the period of the highest reported national incidence of brucellosis, the findings of this investigation are belatedly presented. This paper reports laboratory findings and results of followup investigation of persons with positive agglutination tests for brucellosis, with emphasis on both clinical and epidemiological information. Specific areas of investigation and research have been presented by other investigators (*1–5*).

## Methods

An unknown number of persons are never included in this type of survey because their blood specimens are sent to private laboratories or are tested in hospitals. The persons selected for inclusion in this study were essentially ambulatory outpatients for whom the doctor had submitted a blood specimen to the State laboratory for "febrile agglutination tests." Blood specimens were submitted more frequently by doctors in the more rural areas than by those in urban areas.

Cards requesting pertinent information were mailed to each patient who had a positive agglutination test and to his physician. The patient was requested to supply his name and address, county and township of residence, occupation, and type of food consumed. He was asked to indicate specifically whether or not he used raw milk or raw milk products. If he was a farmer or if he engaged in butchering, he was asked to indicate the type of farming (dairy, hogs, or mixed) and the type of butchering (commercial, home use, cattle, hogs). He was also asked to state whether or not he processed or prepared meat products for home or commercial use. The physician's card requested the name, age, and sex of the patient, diagnosis and stated duration of illness, and information on the presence of 12 selected symptoms.

If the cards were not returned within a month, one followup letter was sent. No further followup was feasible.

Data on 667 of the 884 patients in the study were supplied by the physician; on 596, by the patients; and on 549, by both physician and patient. When information on any characteristic was needed from both physician and patient, the records used were those of the 549 patients for whom records were received from both sources.

For any single characteristic there will be a

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residue of unknowns, either because the questions were not answered or because the answers could not be interpreted. Symptoms not checked by the physician were considered to be absent.

The record in the State laboratory included the month of the test, complete agglutination reading (0−4+ for each dilution 1:20 through 1:1,280), and species of *Brucella* isolated. The information received from the patients and the doctors and the information on the laboratory record were coded, and the complete record for each test was machine punched on one card. Tabulations could then be devised to provide figures for any facet of the data.

## Results

During the 5-year study period, 35,683 blood specimens were tested: 838 specimens had at least a 4+ agglutination at a dilution of 1:80; 1,998 had some reaction at a dilution of 1:40; 32,487 showed no reaction to the *Brucella* antigen.

Of 1,332 bloods selected for investigation, 13 persons were diagnosed "other disease" and were omitted from the study. Of the remaining 1,319 individuals, 102 had entries in more than 1 year, and 333 had multiple tests within the same year; therefore, only 884 persons were actually included in the study. Unfortunately, the number of negative tests on blood specimens from the 884 individuals is unknown.

*Brucella* species were isolated from 139 specimens from 124 patients: *B. abortus* from 87, *B. suis* from 25, and *B. melitensis* from 12. Some multiple isolations were made on the same specimen (*1, 4, 5*).

## Age and Sex

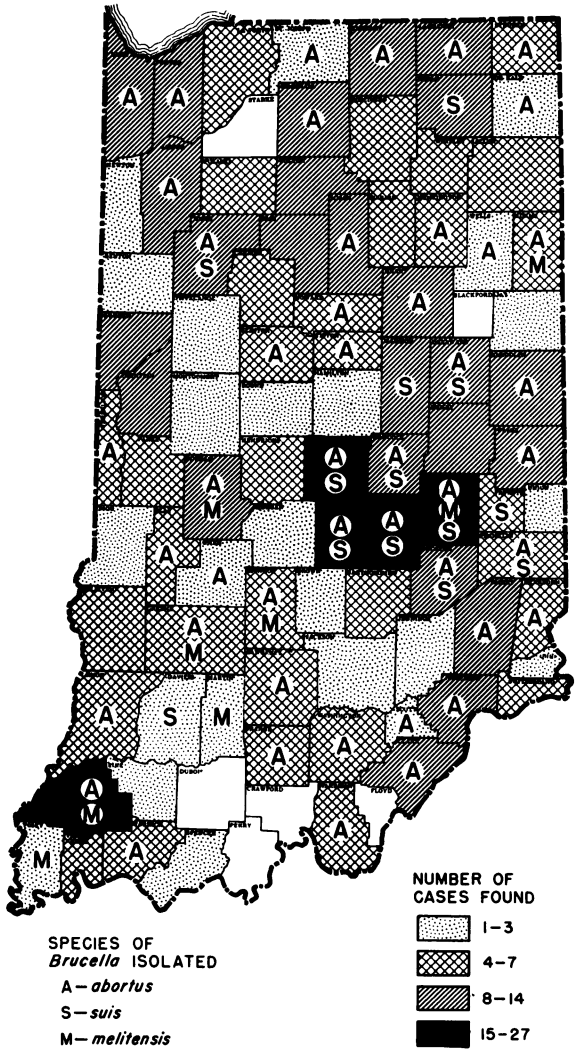
In table 1, the survey population is defined by age and sex for various attributes. The incidence of brucellosis among females, after adjustment for recorded duration of illness before entry into the study, was highest at ages 24–28 and lower but fairly steady through age 50, with a few scattered cases in the ages up through the low seventies. The oldest patient was 77 years old at the time of onset of illness. Males, after similar adjustment for recorded duration of illness, showed a rapidly rising in-

**Table 1. Age and sex distributions of various patient groupings**

| Group and sex | Total | Age in years | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 0–4 | 5–9 | 10–14 | 14–19 | 20–24 | 25–29 | 30–34 | 35–39 | 40–44 | 45–49 | 50–54 | 55–59 | 60 and over | Unknown |
| Total upon first examition | 884 | 1 | 6 | 10 | 16 | 43 | 75 | 85 | 76 | 68 | 64 | 47 | 39 | 51 | 303 |
| Male | 674 | 1 | 3 | 6 | 11 | 32 | 54 | 70 | 61 | 58 | 51 | 37 | 28 | 39 | 223 |
| Female | 210 | 0 | 3 | 4 | 5 | 11 | 21 | 15 | 15 | 10 | 13 | 10 | 11 | 12 | 80 |
| Number diagnosed as brucellosis: | | | | | | | | | | | | | | | |
| Male | 415 | 0 | 1 | 5 | 9 | 27 | 48 | 57 | 50 | 50 | 39 | 30 | 24 | 36 | 39 |
| Female | 120 | 0 | 3 | 3 | 4 | 10 | 19 | 13 | 14 | 10 | 11 | 7 | 10 | 9 | 7 |
| *Brucella* spp. isolated: | | | | | | | | | | | | | | | |
| Male | 106 | 0 | 0 | 3 | 1 | 7 | 16 | 17 | 4 | 10 | 6 | 8 | 3 | 6 | 25 |
| Female | 18 | 0 | 0 | 0 | 1 | 2 | 6 | 2 | 0 | 2 | 0 | 1 | 0 | 0 | 4 |
| Reported duration since onset (months): | | | | | | | | | | | | | | | |
| Unknown or less than 1 | 404 | 1 | 1 | 3 | 5 | 17 | 19 | 17 | 18 | 12 | 13 | 9 | 7 | 11 | 271 |
| 1–11 | 331 | 0 | 3 | 6 | 9 | 18 | 44 | 43 | 39 | 41 | 28 | 26 | 26 | 21 | 25 |
| 12–47 | 103 | 0 | 1 | 1 | 2 | 5 | 11 | 17 | 12 | 11 | 10 | 11 | 3 | 12 | 7 |
| 48 or more | 46 | 0 | 1 | 0 | 0 | 3 | 1 | 8 | 7 | 4 | 13 | 1 | 3 | 5 | 0 |
| All known ages: [1] | | | | | | | | | | | | | | | |
| Male | 451 | 2 | 2 | 8 | 11 | 34 | 64 | 67 | 62 | 57 | 46 | 33 | 30 | 35 | |
| Female | 130 | 0 | 3 | 4 | 7 | 13 | 24 | 15 | 14 | 11 | 10 | 11 | 7 | 11 | |

[1] Adjusted to age at recorded onset.

**Distribution of brucellosis in Indiana, 1946–50**




cidence of brucellosis, beginning at about age 17, reaching a peak at age 30, and decreasing in the thirties. There were sharp peaks in incidence at ages 38 and 40, a slow decline to age 70, and then a more rapid tapering off, the oldest recorded age at onset being 74 years.

No age record was available on approximately one-third of the persons in the study, largely because no information was received from the doctor. The age curves were similar whether or not the physician had made a diagnosis of brucellosis. When the patient's age was recorded, 84 percent of the males and 87 percent of the females were diagnosed as having brucellosis. Only 15 percent of those of unrecorded age were diagnosed.

In 90 percent of the diagnosed cases, the reported duration of illness was 1 month or longer. Adjustment for recorded duration reduced the average age at onset by 12.6 months, 9.7 months for males and 22.3 months for females. The longest average durations were found in the group aged 25–49 years, 10.6 months for males and 26.1 months for females. Duration of illness was shortest in the group under 25 years of age, 7.6 and 6.7 months respectively; those 50 years of age or older had average durations of 8.0 months for males and 24.4 months for females.

## Geographic Distribution

The distribution of brucellosis cases and isolations is shown on the map. Only 6 counties had no cases during the 5-year study period. The number of cases is based largely on the recorded diagnosis of the doctor. A few cases were classified as brucellosis if the organism was isolated or if an agglutination titer of 1:320 or over was found. Gibson, Marion, Johnson, Shelby, and Rush Counties contributed more cases than any other counties, and all had records of isolation of at least two species of *Brucella*. In counties where *B. abortus* alone was isolated, there was no marked concentration of cases.

Isolations were made from residents of 52 of the 92 counties in Indiana. All three species of *Brucella* were isolated from patients from Rush County. *B. abortus* was by far the most common species found and was distributed throughout the State. *B. suis* was most common in the east central area, in a group of contiguous counties with large swine populations. *B. melitensis* was found in 8 counties, 6 of which were in the southwestern part of the State. *B. suis* and *B. melitensis* are regarded as having more discrete enzootic foci in swine. The isolations of *B. melitensis* in Gibson County were largely from packinghouse workers who worked exclusively with swine.

## Symptomatology

Remembering that the doctor is only human and therefore subject to errors in memory, that the patient may not describe his symptoms ac-

curately, and that symptoms may change with different stages of disease, the symptoms recorded for each patient are summarized in table 2 as a percentage of the 581 patients of known age and sex in the group of 667 patients for whom the doctor replied.

Weakness was the most common symptom, regardless of age, sex, chronicity of illness, or isolation of *Brucella*. Females had far fewer night sweats than did males. Females with confirmed cases of brucellosis had more chills, headache, splenomegaly, abdominal tenderness, rheumatism, and arthritis than females with diagnosed cases; however, none of the latter differences were statistically significant.

Since the data were collected by mail, it was interesting to see whether the cases recorded as acute showed any easily identifiable differences in symptoms from the cases recorded as chronic. The excess of symptoms in acute cases over the symptoms in chronic cases is shown for each sex in table 2. The acute cases show significant excesses of evening fever, chills, night sweats, and headache. Females had an excess of backache, abdominal tenderness, and rheumatism. Although splenomegaly was not frequently recorded, it was relatively much more common in the acute cases. In seeming contradiction, in the confirmed cases, splenomegaly was recorded with *B. abortus* only.

Combinations of symptoms were examined in an effort to determine whether any groupings might be designated as pathognomic of the disease, as reported in this study. None were found. The number of patients with the five-symptom combination of weakness, chills, night sweats, headache, and backache, with or without other symptoms, was found to exceed the expected number to a significant degree. Even so, only a third of the patients met the five-symptom criterion. Consideration of the influences of titer, sex, and chronicity might reveal a better combination of symptoms, but the complexity of such an analysis was beyond the scope of this paper.

### Laboratory Findings

In the beginning, the only serums included in the study were those with at least some agglutination at 1:80, using Lederle's standard *Brucella* antigen and the Huddleson slide method. Later, during the period of research on culture methods, blood specimens with lower titers were investigated.

In the third of the patients who had more than one blood specimen with a positive titer, all possible combinations of shifts in titer occurred. Titers tended to be a little lower for cases of long duration, although complete agglutination at titers of 1:320 or above occurred with durations of 10 years or more. Of

**Table 2. Major groupings of patients with the percentages reported as having each listed symptom**

| Symptom | Total persons with a doctor's report including age and sex | | Comparison of doctor's diagnoses of acute and chronic brucellosis | | | | Excess of acute over chronic percentages | | Patients from whom *Brucella* species were isolated | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Male | | Female | | | | | |
| | Male | Female | Acute | Chronic | Acute | Chronic | Male | Female | Male | Female |
| Number of patients | 451 | 130 | 294 | 120 | 70 | 48 | ------ | -------- | 92 | 16 |
| Weakness | 84.6 | 83.1 | 90.8 | 80.8 | 87.1 | 85.4 | 10.0 | 1.7 | 84.8 | 87.5 |
| Evening rise in temperature | 71.7 | 70.0 | 84.0 | 47.5 | 78.5 | 47.9 | 36.5 | 30.6 | 82.6 | 81.2 |
| Chills | 69.0 | 60.8 | 85.7 | 46.7 | 81.4 | 35.4 | 39.0 | 46.0 | 73.9 | 81.2 |
| Night sweats | 66.4 | 40.0 | 82.0 | 47.5 | 55.7 | 25.0 | 34.5 | 30.7 | 75.0 | 43.8 |
| Headache | 68.4 | 68.5 | 82.0 | 56.7 | 78.5 | 62.5 | 25.3 | 16.0 | 73.9 | 81.2 |
| Loss of weight | 50.4 | 42.3 | 60.5 | 46.7 | 45.7 | 41.7 | 13.8 | 4.0 | 65.2 | 50.0 |
| Backache | 54.6 | 56.9 | 57.8 | 55.8 | 67.1 | 47.9 | 2.0 | 19.2 | 48.9 | 56.2 |
| Splenomegaly | 8.0 | 9.2 | 10.9 | 5.0 | 12.9 | 2.1 | 5.9 | 10.8 | 13.1 | 25.0 |
| Abdominal tenderness | 22.9 | 31.5 | 24.5 | 25.0 | 42.8 | 22.9 | −.5 | 19.9 | 23.9 | 43.8 |
| Rheumatism | 27.8 | 36.9 | 28.2 | 26.7 | 35.7 | 22.9 | 1.5 | 12.8 | 29.3 | 43.8 |
| Arthritis | 17.1 | 19.2 | 17.7 | 20.8 | 22.8 | 25.0 | −3.1 | −2.2 | 16.3 | 31.2 |
| Anemia | 18.0 | 27.7 | 20.4 | 23.3 | 28.6 | 31.2 | −2.9 | −2.6 | 22.8 | 31.2 |

**Table 3. Probability of isolation of Brucella from blood clots, for each agglutination titer**

| Titer level | Number of isolations | Probability | 95.5 percent confidence limits | |
|---|---|---|---|---|
| | | | Upper | Lower |
| 0 | 3 | 0. 0004 | | |
| 1:40 [1] | 34 | . 098 | 0. 130 | 0. 066 |
| 1:80 | 35 | . 141 | . 185 | . 097 |
| 1:160 | 29 | . 171 | . 229 | . 113 |
| 1:320 | 11 | . 157 | . 244 | . 070 |
| 1:640 | 8 | . 258 | . 415 | . 101 |
| 1:1,280 | 4 | . 286 | . 528 | . 0 |

[1] Includes incomplete agglutinations at this titer.

course, there is always the possibility of reinfection.

These data clearly demonstrate a relation between titer and probability of isolation of *Brucella* even though the quantitative values cannot be assumed to provide a standard. Some one species of *Brucella* was found in the blood samples of 124 of the 884 persons in the study (table 1). The population estimate for the negative blood specimens was 7,393 (*5*). The probability of making an isolation starts at 0.0004 for negative blood samples, is 0.10 for a titer of 1:40, rises to 0.17 for 1:160, and reaches 0.29 for 1:1,280, the highest dilution tested (table 3). Due to the decrease in numbers of specimens with increase in titer, the confidence limits of this relation are broad at the higher titers.

Although there was no strong correlation between blood titer and isolation of organisms, titers accompanied by isolation were higher for specimens taken 2 to 4 months after onset of illness than for those taken during the month of onset or the first month afterward. During the month of onset, titers for *B. suis* were definitely higher than titers for other species. Acute brucellosis was associated with a higher average titer than chronic brucellosis, but both ran the full range of titers.

**Table 4. Seasonal distributions in various classifications of patients**

| Classification | Month | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jan. | Feb. | Mar. | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | Total |
| | Distribution before adjustment | | | | | | | | | | | | |
| Specimens submitted: [1] | | | | | | | | | | | | | |
| All blood specimens | 93 | 85 | 110 | 86 | 99 | 108 | 137 | 144 | 121 | 141 | 83 | 110 | [2] 1,317 |
| First bloods only: | | | | | | | | | | | | | |
| Number | 65 | 55 | 81 | 60 | 72 | 74 | 98 | 94 | 76 | 86 | 51 | 70 | [2] 882 |
| Geometric mean titer | 1:92 | 1:76 | 1:72 | 1:82 | 1:88 | 1:90 | 1:78 | 1:80 | 1:90 | 1:98 | 1:94 | 1:89 | |
| Isolations of *Brucella:* | | | | | | | | | | | | | |
| Total | 10 | 7 | 6 | 12 | 10 | 17 | 17 | 13 | 14 | 8 | 3 | 7 | 124 |
| *B. abortus* | 9 | 6 | 6 | 8 | 7 | 10 | 7 | 8 | 11 | 6 | 3 | 6 | 87 |
| *B. suis* | 1 | 1 | 0 | 4 | 1 | 3 | 6 | 4 | 2 | 2 | 0 | 1 | 25 |
| *B. melitensis* | 0 | 0 | 0 | 0 | 2 | 4 | 4 | 1 | 1 | 0 | 0 | 0 | 12 |
| Brucellosis diagnosed by physician: | | | | | | | | | | | | | |
| Acute | 23 | 22 | 26 | 25 | 30 | 34 | 50 | 44 | 34 | 31 | 21 | 24 | 364 |
| Chronic | 14 | 7 | 21 | 9 | 6 | 9 | 17 | 18 | 21 | 23 | 10 | 16 | 171 |
| History of animal contact: [3] | | | | | | | | | | | | | |
| Any recorded contact | 25 | 18 | 30 | 20 | 21 | 32 | 42 | 31 | 32 | 29 | 19 | 25 | 324 |
| No recorded contact | 15 | 21 | 23 | 16 | 29 | 19 | 34 | 35 | 25 | 27 | 17 | 21 | 282 |
| | Distribution after adjustment to month of onset | | | | | | | | | | | | |
| First bloods | 64 | 60 | 78 | 73 | 77 | 78 | 85 | 83 | 70 | 88 | 52 | 74 | 882 |
| All diagnoses | 36 | 30 | 44 | 42 | 29 | 39 | 67 | 62 | 52 | 59 | 31 | 44 | 535 |
| Total isolations | 10 | 5 | 14 | 16 | 11 | 17 | 7 | 15 | 13 | 5 | 5 | 6 | 124 |

[1] With at least some titer at 1:40.
[2] No month recorded for 2 specimens.
[3] Slaughtering, butchering, processing.

### Seasonal Distribution

The frequency of positive agglutination tests showed low peaks in December and March, with a high incidence in July–October (table 4). The geometric mean titer does not fit the curve of number of tests, isolations, or number of diagnosed cases. Expected numbers of isolations, calculated for each month on the basis of probabilities by titers, as shown in table 3, fell short of the observed 83 isolations for April–September by 18, a very significant deficit. These 6 months were responsible for 32 of the 37 isolations of *B. suis* and *B. melitensis* and for 51 of the 87 *B. abortus*. The diagnosis of chronic brucellosis had modes in March, September, and October, whereas acute brucellosis showed excesses in May–October, with modes in July–August. There was a significant disproportionality between the number of persons with and without animal contact only in the month of May. When the figures were adjusted to month of onset, insofar as possible, some minor shifts occurred. The only shift worth noting is the increase in isolations from 6 to 14 in March, 5 attributed to *B. suis* and 3 to *B. abortus*.

### Possible Sources of Infection

The major possibilities of exposure to brucellosis, shown in table 5, are based on the 596 reports returned by persons whose blood was tested in the State serology laboratory and found positive at some titer. Adequately classified population groups cannot be enumerated to permit a calculation of specific attack rates.

Within this study, it is possible to examine the proportions of patients whose blood is culturally positive when classed by various possible methods of exposure. The results do not indicate the risk of exposure, although they could be an index of the amount or method of exposure. Also, the more severely afflicted persons may have been more likely to answer the questionnaire than persons less severely afflicted.

The gross rate of recovery or isolation of *Brucella* was 16.9 per 100 for the 596 patients who returned a questionnaire and 8.0 for the 288 who did not. The difference between the two rates is highly significant. The rate for females was lower than the rate for males to a highly significant degree. The packinghouse workers had a perfect record of 9 for 9. Exclusive of this 9, persons with butchering or meat processing exposure had a rate of 17.5. In both males and females, the record of contact with any meat or carcass was associated with a higher rate of recovery of *Brucella* than records of other exposures. There was no evidence that the use of raw milk products was associated with a higher rate of recovery of organisms than meat or farm contacts. In fact, the 81 persons who stated that they did not use raw milk had the same rate of recovery of *B. abortus* and a higher rate for all species than the users of raw milk.

Opportunities for exposure to *Brucella* were ubiquitous; no single type of contact can be

**Table 5. Major classifications of exposure and rates of isolation of Brucella species in study population**

| Exposure classification | Total persons | Rate of recovery of *Brucella* in exposure group/100 | |
|---|---|---|---|
| | | *B. abortus* only | All 3 species |
| Total persons with any exposure information | 596 | 11.7 | 16.9 |
| Remainder | 288 | [2] 5.9 | [2] 8.0 |
| Packinghouse workers [1] | 9 | 0 | 100.0 |
| Total with definite milk status | 537 | 11.7 | 16.6 |
| Male | 413 | 13.1 | 18.4 |
| Female | 124 | [2] 7.3 | [2] 10.5 |
| Males: | | | |
| Meat contact [3] | 230 | 13.9 | 20.0 |
| Farm contact [4] | 322 | 13.7 | 17.4 |
| Raw milk used | 349 | 13.2 | 16.9 |
| Meat and milk | 197 | 14.7 | 18.8 |
| Farm and milk | 288 | 13.2 | 16.3 |
| Meat and farm | 194 | 15.5 | 19.1 |
| Meat, milk, and farm | 177 | 15.3 | 18.6 |
| Females: | | | |
| Meat contact | 69 | 11.6 | 17.4 |
| Farm contact | 70 | 8.6 | 12.8 |
| Raw milk used | 107 | 7.5 | 10.3 |
| Meat and milk | 64 | 12.5 | 17.2 |
| Farm and milk | 64 | 9.4 | 12.5 |
| Meat and farm | 55 | 10.9 | 16.4 |
| Meat, milk, and farm | 52 | 11.5 | 15.4 |

[1] 6 included in subsequent groups.
[2] Rates are highly significantly lower than line above.
[3] Any contact with carcass or meat—slaughtering, butchering, processing.
[4] Farmers, farm residents, farm laborers.

incriminated. The number of males with farm and meat contacts and the number of females with no farm contact exceeded the numbers expected. Contacts with meat and milk were closely associated with farm contact, which, simply put, indicates that rural activities offer the greatest opportunity for exposure to *Brucella.*

### Duration, Incidence, and Prevalence

The distribution of months of duration since onset of illness may be based on two sources. First, at the time of entering the survey, 24.5 percent of the patients had records of duration of illness of 12 months or longer, and 6.3 percent had recorded durations of 5 years or more (table 6). Second, if the 884 persons in the study population had remained in the study for a full 5 years, an estimated 73 persons (8.3 percent) would have re-entered the study after 1 and under 5 years.

**Table 6. Distribution of recorded duration of brucellosis upon entry to the study**

| Recorded duration | Frequency | Percent |
|---|---|---|
| Months: | | |
| 0–3 | 370 | 63.5 |
| 4–11 | 70 | 12.0 |
| Years: | | |
| 1 | 45 | 7.7 |
| 2 | 29 | 5.0 |
| 3 | 17 | 2.9 |
| 4 | 15 | 2.6 |
| 5 | 11 | 1.9 |
| 6–10 | 16 | 2.7 |
| 11–20 | 10 | 1.7 |

The percentage of the study population in each duration interval provided a base for an estimate of the probability of a return case of brucellosis. Using the number of previously reported cases in the United States as a population, an estimate was made of the number of return cases to be expected. In 1950, reported cases of brucellosis in the United States numbered 3,510, and the estimated number of return cases is 2,257; in 1955, the figures were 1,232 and 1,875, respectively. The estimate for 1960 is 443 reported cases and 1,314 return cases.

Data on reported cases of brucellosis for the United States as a whole are not restricted to new cases, but under-reporting more than balances the confusion between prevalence and incidence. For instance, from these data physicians reported a diagnosis of brucellosis in 535 cases, whereas only 437 cases were reported officially to the Indiana State Board of Health. State records were unavailable for comparison of names, but a comparison of the two sets of records by county and year showed that only 263 cases coincided, making a minimum of 709 diagnosed cases of brucellosis in Indiana, during the period 1946–50.

### Discussion

The data in this paper provide information on brucellosis in an essentially rural population and probably are deficient concerning urban populations in occupations which present opportunity for exposure to brucellosis through contact with animals. One unique feature of the study is the reply by 85 percent of those who answered questionnaires that they used raw milk or raw milk products. In a similar study in Iowa, only 55 percent of the study population reported use of raw milk or raw milk products (*6*). In this study, even among persons with no known animal or farm contacts, 76 percent were users of raw milk, in contrast with the 56 percent reported in Wisconsin (*7*). While the noncontact cases approached a 1:1 sex ratio in the use of raw milk, all isolations of *B. abortus* occurred in males, in contrast to Minnesota data (*8*), which gave a 1:1 ratio between noncontact cases with isolation.

Laboratory data, lending support or confirmation to the clinical picture, often are considered indispensable to the final diagnosis of brucellosis. However, the sources of variability in laboratory results are numerous. These data show that any observed titer for a given person's blood represented a quite transitory condition and might exhibit any pattern of changes over a short or an extended period of time. The changes, or lack of changes, in titer could not be related to other attributes in the study. Original isolations followed by later tests, with or without isola-

tion of *Brucella*, showed no change in titer in 11 individuals, rises in titer in 21, and decline in titer in 13. There were no differences in titer between species. Titer was not a strong influence in the differential diagnosis of chronic and acute brucellosis.

Magoffin and others, using a tube method and BAI antigen, found titers of 1:320 or greater in over 90 percent of 267 culturally proved cases of brucellosis in Minnesota (*8*). The frequency distributions of titers in Indiana and in Minnesota were similar but in Minnesota the titers were approximately 5 dilutions higher, or 32 times as dilute, as in Indiana. The methods in the two States differed, but it is likely that the Indiana study of culture methods revealed positives at truly lower titers. *B. abortus* was predominant in both surveys, Minnesota had more *B. melitensis*, and Indiana had more *B. suis*.

In this study, one of each of the three species of *Brucella* was found in blood specimens with no agglutination titer. The chances of recovering the organism increased as the titer increased. Damon and co-workers, using most of the same blood specimens reported on here, found that the method of culturing also was important in the number of recoveries of *Brucella* (*1*). The yolk sac technique was twice as effective as C–V broth, which in turn was definitely superior to the best guinea pig method. Research on the yolk sac method lasted only long enough to isolate 14 strains of *Brucella*, so it is entirely possible that well over 200 isolations could have been made instead of 139 if the yolk sac culture method had been used throughout the study.

Contrary to the observation of Gay and Damon (*4*), 15 *B. abortus*, 3 *B. suis*, and 1 *B. melitensis* were isolated from patients with a diagnosis of chronic brucellosis. In 9 cases, however, the reported duration of illness was less than 12 months. Two cases, one with isolation of *B. abortus* and one with isolation of *B. suis*, had initial diagnoses of acute brucellosis, but later in the study the disease was diagnosed as chronic. Another case had a positive blood titer 19 months before the isolation of *B. suis*, with the diagnosis of chronic brucellosis and a total recorded duration of illness of 43 months. Still another had two isolations of *B. suis* 6 months apart, with respective diagnoses of acute and chronic brucellosis. This also was the longest recorded interval between successive isolations.

In Iowa, Hendricks has shown a closely similar pattern between the seasonal distribution of cases of brucellosis in male farm workers and the incidence of sows farrowing (*6*). In Indiana, the incidence of brucellosis in man did not parallel the farrowing curve of sows. These differences are not unexpected since the swine industries of Iowa and Indiana are considerably different in relation to total livestock.

Information on brucellosis from 16 other States was examined for comparison of data on age and sex. Most of the data were for 1949. In that year, the ratio of males to females varied from 0.8 in Washington and 0.9 in Kentucky to 4.9 in Minnesota and 4.8 in North Dakota. The 3.5 ratio for Indiana was intermediate. In Iowa and Minnesota, the ratio of males to females increased with time but decreased in Washington and remained constant in Wisconsin. In Minnesota, a recent decrease in brucellosis cases among females caused the increase in ratio of males to females. Data from Iowa for 1949 and 1952–53 indicate increases in the proportions of packinghouse workers and workers in related industries who have brucellosis, and decreases in the proportions of children and housewives who have the disease. Hendricks confirms this observation (*6*).

Age and sex data were supplied by the health departments of the following States:

| | |
|---|---|
| Connecticut | North Dakota |
| Colorado | Ohio |
| Illinois | Oregon |
| Iowa | Tennessee |
| Kentucky | Vermont |
| Michigan | Virginia |
| Minnesota | Washington |
| New York | Wisconsin |

Data for the same 16 States showed that where the ratio of males to females was high, the difference was apparent by the age of 5–9, was most marked in young adulthood, and decreased with age, in agreement with Feig (*7*) and with the Indiana data. Shifts in the age of brucellosis patients in Iowa and Wisconsin from one year to the next would make one sus-

pect that similar variations from State to State could have little epidemiological value.

Since brucellosis is reported to be transmitted rarely from man to man, age and sex distribution is largely a reflection of the occupations of the patients, of the general economy, and of the distribution of the disease in animals, peculiar to geography and time. Biases in reporting will contribute to differences in incidence of brucellosis between States. We may expect, on these bases, that epidemiological information will be peculiar to a State and will be influenced by the year of occurrence of reported cases.

Data from other States are compatible with the finding in this study of 25 percent of patients with recorded durations of brucellosis longer than a year. Spink and Magoffin observed a group of 185 patients whose infections were severe enough to require hospitalization (*9*). Of 65 untreated persons, nearly half had subjective symptoms after a year but only an eighth still had disability. Giedt reported that 51 percent of the reported cases of brucellosis in Washington in 1950 had durations of 1 year or longer, and 11 percent had durations of 5 years or more (*10*). Corresponding data for 1945–47 were 24 percent and 7.5 percent. Eisele has shown that a majority of patients have prompt remissions with several antibiotic regimens, but that relapse is all too common (*11*). Other investigators have arrived at the same essential conclusion: No sure cure for brucellosis has been discovered. Feig pointed to the use of antibiotics as one factor in the decrease of reported brucellosis, through symptomatic treatment without differential diagnosis (*7*).

These observations place considerable importance on differentiating between the new cases of brucellosis and relapse, exacerbation, or reinfection, in assessing the significance of the brucellosis problem in the immediate future.

## Summary

During the 5-year period 1946–50, the Indiana State Board of Health laboratory performed 35,683 slide agglutination tests for *Brucella*. Incomplete reaction at 1:40 was noted in 1,998 blood specimens, and 838 showed complete agglutination at 1:40 or higher. Mailed questionnaires sought additional information from 884 patients and their doctors. The descriptive statistics: 674 males, age range 2–74, mean 39.2, modes 29, 30, 40 years; 210 females, age range 6–77, mean 37.3, modes 24, 26 years; 364 diagnosed acute, 171 chronic; 87 *Brucella abortus*, 25 *Brucella suis*, and 12 *Brucella melitensis* isolations; average recorded duration 12.6 months, 9.7 for males and 22.3 for females; 24.5 percent with recorded duration 12 months or longer, 6.3 percent with 5 years or more. The probability of isolation was directly related to titer being 0.1 for 1:40 and 0.29 for 1:1,280 or over.

Major classes of occupation-contact for 596 persons were: 456 used raw milk, 81 did not; 317 butchered or processed meat for home use; 423 resided on farms or had farm contacts; 27 were packinghouse workers or commercial butchers.

The most common recorded symptom was weakness. The most prominent combination of five symptoms was weakness, chills, night sweats, headache, and backache. Fever, chills, night sweats, and headache were much more common in patients with acute brucellosis. Females had significantly fewer night sweats than males, but more backaches, abdominal tenderness, and rheumatism.

There were more tests, isolations, and diagnoses in July–October, with secondary peaks in December and March–April. Large numbers of cases were found in areas with large swine populations.

If recorded durations of cases are reliable and representative, the prevalence of brucellosis in the United States in 1955 should have been over twice the incidence, and, with present trends, prevalence in 1960 will exceed four times the incidence.

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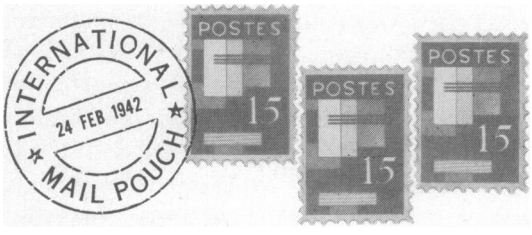


## *National Health Congress*

The first National Health Congress of Vietnam, sponsored by the Ministry of Health, was held in April 1956. Each province was represented. More than 100 physicians, as many health service personnel, and members of national and international organizations attended. Leading pharmaceutical companies of Vietnam displayed educational exhibits of modern drugs. The well-chosen exhibits attracted the attention of physicians and laymen alike.

—HARRY H. STAGE, *acting chief, Health and Sanitation Division, United States Operations Mission, Vietnam.*

## *Pan Brazilian Textbook*

Thirty-one teachers and three sanitary engineers have volunteered to contribute 38 chapters to a Pan Brazilian textbook on water supply and sewerage, and have completed about half of the text.

The book is being written by Brazilians, for Brazilians, to fit Brazilian conditions. Authors represent engineering colleges, from the Amazon to Rio Grande do Sul, as well as sanitary engineers in government employ. The project will produce a textbook in the Portuguese language for engineering students, point the way to textbooks in other fields, create uniform Brazilian technical standards and nomenclature, attract the attention of educators and others to the needs of sanitary engineering education, and improve the morale and methods of sanitary engineering instructors.

—E. ROSS JENNY, M.D., *chief, Health and Sanitation Division, United States Operations Mission, Brazil.*

## *Monuments*

The requirement that all structures built with point 4 funds have a permanent identification created a problem. Any permanent marker would have been too costly for the 1,500 pit privies we had helped build, and for the 10,000 more anticipated, at an average cost of about $15.

We discussed the matter with owners of the privies. One proud owner suggested that since the privies have concrete floor slabs and brick superstructures, permanent imprints could be stamped in the floor slab or one of the bricks as the parts are made. The idea sounded so good that we have had a form of the emblem and other necessary materials prepared. Each structure will have its permanent marker at negligible cost.

—ARTHUR L. DOPMEYER, *formerly acting chief, Technical Service for Health and Sanitation, United States Operations Mission, Jordan.*