Brucellosis in Pork Slaughterhouse Workers

Community Research by Family Practice Residents

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As a community health project in a family practice residency, a serologic survey for brucellosis was conducted among meat plant workers in Detroit. Eleven United States Department of Agriculture (USDA) inspectors and a control population were also tested. Workers in two large Detroit slaughterhouses were found to have significantly higher brucella antibody titer levels than the control population, indicating probable exposure to brucellosis. A total of 47 workers and two USDA inspectors were found to have standard tube agglutination titers (SAT) of $\geq$1:80, which is a titer level compatible with active disease. Examination of these workers revealed probable disease in eight of them. These figures suggest that brucellosis poses a definite health risk to pork slaughterhouse workers in Detroit. The project demonstrates how family practice residents can cooperate with public health officials and industry in identifying and quantifying health hazards in the community.

As the discipline of family medicine matures as a field of academic specialization, there is a recognized need for training of family practice residents in research methods and for focusing research on areas of particular relevance to family practice.

The philosophy of the Wayne State University-sponsored family practice residency program is that family physicians not only should be prepared to provide quality, family-oriented care in the office and in the hospital, but also should be concerned for the well-being of citizens in the community. The community medicine rotation in the residency program has been designed to provide time for residents to become knowledgeable about health problems in the community and to pursue solutions to these problems. An awareness of community health hazards and a training in research methodology will equip residents with the tools for community involvement in their future practice settings.

The research project reported in this paper demonstrates how the interests of an individual resident can be combined with a need in the community to benefit all concerned. It also provides an example of the many opportunities available for community-based research in large metropolitan centers and the various resources which can be used to assist residents in acquiring the desired training. In this instance, the Departments of Family Medicine and Comparative Medicine of the Medical School and the Detroit Department of Health participated in the designing of the project and provided the necessary laboratory space,

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financing, professional advice, and other resources required for the study.

Investigation of brucellosis in slaughterhouse workers was chosen for several reasons. First, veterinarians in the Department of Comparative Medicine interested in urban zoonoses suspected that there was a higher incidence of brucellosis in slaughterhouse workers than was reported. From 1965 to 1974 there were 25 cases of brucellosis reported in the state of Michigan.[1] Review of the files of the Detroit Department of Health revealed only three reported cases during the previous five years from slaughterhouse workers.

Secondly, the project had an educational rationale in that a project of this type conducted in the meat processing plants would provide an opportunity to test and demonstrate a clinical research model in which physicians going to the work place could simultaneously provide service and perform a useful piece of research.

Thirdly, a systematic study of workers at high risk for brucellosis had not been previously conducted in Detroit.

The primary objective was to screen pork slaughterhouse workers in Detroit serologically for the presence of brucella antibodies. If the initial screening yielded a significant occurrence of clinical and subclinical disease, this would provide the necessary information to design a program of more adequate preventive health care for workers in this environment.

Background

The incidence of brucellosis in the United States peaked in 1947 with 6,321 reported cases of human disease. During that same year, the Brucellosis Committee of the United States Livestock Sanitary Association, with the Bureau of Animal Industry, launched a state-federal eradication program which called for the testing and slaughter of reactors, a thorough cleaning and disinfecting of barns or buildings that housed reactors, retests at frequent intervals, and the vaccination of calves if deemed suitable.[2] Other approaches included increased emphasis on the pasteurization of milk and the slaughter of entire herds of swine. All of these efforts brought about a dramatic decline in the incidence of human disease, so that in 1976 there were only 271 reported cases.[3]

While the number of cases in the general and farm populations has declined, brucellosis continues to be an occupational hazard for meat processing plant workers. From 1965 to 1974, 52 percent of reported cases were in slaughterhouse and processing plant employees.[1] Seven major outbreaks of the disease have been reported in slaughterhouses in recent years.[4-10]

Methods

Four Detroit plants were surveyed. Two of these were slaughterhouses (S1 and S2), and two were processing plants (P1 and P2). S1 and S2 account for the slaughter of more than 90 percent of swine in Detroit, with S1 slaughtering 8,500 hogs per day and S2, 6,500 hogs per day. These plants slaughter butcher class hogs. (Sows and boars are butchered in smaller, outlying slaughterhouses.) Most of the hogs are raised in other states and transported to Michigan.

S1 employs approximately 390 people; P1, 180; S2, 300; and P2, 40. The ethnic make-up of the plants is roughly one third Black, one third Anglo, and one third Slavic, Middle Eastern, and other.

All data on the volunteers were obtained from a questionnaire which was filled out immediately before the venapuncture. Information obtained in the questionnaire included place of birth, work area, years worked in plant, number of sick days during the past year, previous exposure, and whether or not glasses were worn at work. No previous medical records of employees were available.

A group of 11 USDA inspectors was also tested during the visit to S2. The inspectors were handled as a separate test group.

The control sample was obtained from the Harper-Grace Wayne State University (WSU) Family Practice Center patient population. Blood samples (7 ml) were taken from 175 consecutive patients visiting the center, age 20 to 60 years, when blood was drawn for other purposes. The control population was 40 percent male and 60 percent female.

As is well documented in other studies,[4-7,10] the areas of highest exposure risk to brucellosis are those where warm meat is directly handled. These are essentially the "kill," pen, rendering, and casing areas. Since brucella organisms are only viable between 20 and 40 C, the cooling process theoretically renders the meat "clean" of brucellosis. Hence, since P1 and P2 receive meat that has been cooled, workers in these plants should be at minimal risk.

Table 1. Number of Positive (1:80) Titers by Plant Compared to Controls

Titer	≤1:40	≥1:80	Totals
S1	150	*17	167
S2	185	*23	208
P1	108	5	113
P2	37	2	39
Inspectors	9	2	11
Controls	171	4	175

*Significantly different from control group for P<.02.

A research team composed of two family practice residents, one medical student, and other staff of the Department of Family Medicine gained entry into S1 and P1 with ownership approval and into S2 and P2 with union assistance. Advance educational and public relations work was performed one week prior to the blood drawing. Consent forms which included a half-page description of the symptoms and overall implications of brucellosis were signed by employees. The test was conducted on a volunteer basis for all interested employees of these four plants. Venapuncture was performed exclusively during coffee and lunch breaks. Blood pressure checks were available as an added incentive for participation. All participants were informed that those showing positive tests would be examined and, if appropriate, treated without charge.

Blood was drawn in 5 cc vacutainer tubes. At the end of each venapuncture day, the blood was transported to the laboratory where it was centrifuged at 1,500 rpm for ten minutes. The serum was then separated, placed in 5 ml Pyrex brand tubes, and immediately frozen at -80 C. All serum was then tested within one week of initial freezing.

The test used for the survey was the standard tube agglutination (SAT) method. Protocol for the test procedure was obtained from the Michigan Department of Public Health—Bureau of Laboratories. The test results were interpreted within World Health Organization (WHO) guidelines.[11] Brucella abortus antigen was obtained from the USDA Animal and Plant Health Service, Veterinary Diagnostic Laboratory, Ames, Iowa.

The choice of using the SAT as a test preference was based on the reliability of the test, its general acceptance nationwide and worldwide, and the fact that the laboratory and materials available were most compatible with the use of this test. Comparisons of the different serologic test procedures such as the Coombs test, the complement fixation test, the fluorescent antibody test, the plate agglutination test, and the 2-mercaptoethanol test (2M-E) are common[10-12] and are in agreement that the SAT is reliable and accurate and yields few false negatives.

Each specimen was tested in eight serial dilutions from 1:10 through 1:1,280. All laboratory testing was performed by three residents in the Department of Family Medicine, under the supervision of one of the authors (ABT) of the Department of Comparative Medicine. This not only provided laboratory experience for the residents, but also had costsaving implications. An arbitrary titer level of 1:80 was considered a "positive" test, and therefore compatible with active disease. There is general agreement for this standard in the literature.[13,14]

The relationship of positive SAT titer level to work area in the plant, length of employment, US vs non-US birthplace, gender, previous exposure to brucellosis, number of sick days per year, and the wearing of eye glasses was tested using the chi-square test for independence. Total positive titers per plant were compared between plants and to the control sample using chi-square, also.

**Table 2. Brucellosis Case-Titer Reports by Work Area*
S1 and S2 Combined**

Titer	Killing	Cutting	Multiple Work Area	Office	Shipping
0	99	77	55	6	6
1:20	13	6	1	1	0
1:40	5	4	3	0	1
1:80	7	2	9	0	0
1:160	3	5	0	0	0
1:320	3	1	2	0	0
1:640	0	1	1	0	0
1:1,280	1	0	1	1**	0
Total	131	96	72	8	7

*Workers who did not specify work area (61) and inspectors (11) were omitted from this table.
**This particular office worker was totally asymptomatic with a normal physical examination. Her elevated titer was unexplained.

Results

There were 164 volunteers tested in S1, 113 in P1, 208 in S2, and 39 in P2. These numbers corresponded to a 50 percent, 60 percent, 90 percent, and 100 percent volunteer rate in S1, S2, P1, and P2, respectively. These volunteer rates reflect the number of employees being tested divided by the number of employees working on the day of venapuncture. High volunteer rates in S2 and P2 could be related to the fact that the health team entered these plants with strong support from the union.

Eighteen percent of workers in S1 and 23 percent of those in S2 had titers of ≥1:40. Titers of ≥1:80 (the titer level considered compatible with active disease) were recorded in 10 percent and 11 percent of the workers tested in S1 and S2, respectively (Table 1). Titers of ≥1:80 and ≥1:160 could not be significantly correlated with gender, the wearing of eye glasses, work duration, birthplace, or number of sick days. However, when S1 and S2 were analyzed by work area, the findings were suggestive, with workers in the kill and cut areas of the plants showing higher titers than the office and shipping areas (Table 2).

When titer levels by plant are compared to matching titer levels in the control population, the findings become very significant. Numbers of titers ≥1:80 were significantly greater in S1 and S2 (the slaughterhouses) than in the control population. There was no significant difference in titer levels between P1 (processing) and the control population (Table 1). This was expected as P1 handles only "cold" meat.

Of the 11 USDA inspectors tested, three had reactive titers of 1:40, 1:80, and 1:160. The 1:160 reactor was a veterinarian who gave a history of accidental self-inoculation with brucella vaccine in the recent past.

A total of 47 meat plant employees tested and two of the USDA inspectors tested registered SAT titers of ≥1:80. Contact was made with 36 of these workers and both USDA inspectors. These 38 individuals were screened by questionnaire for symptoms of active brucellosis. Fifteen of the 38 (14 workers, one inspector) were felt to have symptoms compatible with active disease. These 15 were then examined in the Family Practice Center. Eight of these showed a sufficiently high suspicion for active brucellosis to warrant treatment. Two of the eight chose to be referred to their private physicians and six were treated with a three-week course of tetracycline, 500 mg every six hours, through the Family Practice Center. Due to financial and time limitations, blood cultures and repeat titers were not taken. SAT titers of ≥1:80 with suspicious signs (rash, organomegaly, lymphadenopathy, fever, diaphoresis) or

symptoms (weight loss, night sweats, malaise, arthralgias) resulted in a sufficiently high index of suspicion to warrant treatment. Two of those treated under these criteria exhibited a Herxheimer reaction, one to two days after the onset of treatment, with resolution of symptoms. Two others claimed an improvement in symptoms.

Discussion

The results of this survey indicate that brucellosis is indeed an occupational risk to pork slaughterhouse workers in Detroit. Clinical follow-up of suspected cases reinforces this view, since eight suspected cases have been uncovered. A more actively organized risk monitoring program is required to diagnose and treat workers *promptly* after exposure to infected hogs. This would necessitate ongoing availability of diagnostic screening and immediate treatment in the plants, and active union and management participation. A follow-up plan resulting from this study is to develop an acceptable brucellosis detection program in Detroit area slaughterhouses.

As in the past, the packing industry remains reluctant to accept brucellosis as an occupational disease.[15,16] This was evident when the results of the survey were forwarded to plant managements. Other routes of plant entry may be necessary for future screening and treatment. These routes could include entry with union assistance (which was very successful in S2 and P2) and entry with the aid of the public health department.

The state of Iowa presently has mandates for yearly blood screening for brucellosis in meat packing workers. Iowa also considers brucellosis a compensable occupational disease. Certain countries, including England and Argentina, also consider it occupation-related and compensable. Several countries, including Sweden,[17] have eradicated brucellosis altogether. Eradication of brucellosis in the United States cannot be anticipated for the immediate future under current industry policy and practices. Much more active public health intervention and packing industry cooperation will be needed.

As mentioned above, the present study serves as an example of community oriented research in an urban area. Studies of this type can be a valuable component of family practice residency training and can provide opportunity for research and service (diagnosis, treatment, follow-up, and patient education) for family practice residents. Through such projects, some residents may be stimulated to pursue community research after entering practice; some may also become involved in the health care issues of occupational risks and working conditions. Investigations of this type will help identify the specialty of family practice as one which considers individuals and families as integral parts of the community and social environment.

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