OCCUPATIONAL RESPIRATORY DISEASES

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BRUCELLOSIS

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DEFINITION

Brucellosis is an infectious disease caused by microorganisms of the genus *Brucella*. It usually affects domestic animals but can be transmitted to humans. Domestic animal diseases that are of public health concern are caused by *Brucella abortus, Br. suis,* and *Br. melitensis. Br. abortus* most commonly infects cattle, causing abortion late in pregnancy and a subsequent high infertility rate. Brucellosis in swine is most often caused by *Br. suis* and is a chronic disease manifested by sterility or abortion in sows, high piglet mortality rates, and orchitis in boars. *Br. melitensis* is the most common cause of brucellosis in goats, causing abortion late in pregnancy. *Br. canis,* affecting mainly dogs, has been associated with only a limited number of human infections and appears to be a less important human public health concern than the other three species.

Brucellosis in humans can be caused by any of the *Brucella* species and is an illness characterized by fever, chills, sweating, malaise, weakness, headache, myalgia, anorexia, and loss of weight.

ETIOLOGY

The etiological agents of Brucellosis are *Brucella abortus, Br. suis* and *Br. melitensis.* These Brucella microorganisms are pleomorphic, short, and slender coccobacilli. They stain gram-negative; bipolar staining is sometimes present. Differential characteristics of Brucella species based on physiological requirements and gas formation, growth in the presence of dyes, oxidative metabolic activities, lysis by phagocytes, and agglutination in monospecific antisera help identify individual species. No exotoxins are formed, but the cell has enterobacterial endotoxins.

OCCUPATIONS AND INDUSTRIES INVOLVED

As an occupational disease, brucellosis occurs in livestock producers, veterinarians, and rendering plant and abattoir employees. The incidence of the disease in the United States is steadily declining, with only about 200 cases currently being reported annually. Approximately half of the cases, primarily those in abattoir workers, are acquired from exposure in an industrial setting (Table IX-1)(5).

EPIDEMIOLOGY

In the United States, the reported incidence of brucellosis has declined from a peak of 6,321 cases in 1947 to its current plateau of 200 cases per year. Pasteurizing dairy products and attempting to eradicate the disease from livestock have been primarily responsible for the falling incidence of human brucellosis. Proportionately more abattoir employees than members of the general population continue to acquire brucellosis; of 2,126 cases from 1968 to 1977 for which information was available, 1,215 (57%) were in abattoir workers.

One investigation of brucellosis infection rates and route of infection in a swine abattoir (EPI 74-2-3, consultation on abattoir-associated brucellosis, Smithfield, Virginia, issued March 1974) revealed a 9% rate of seropositivity, and a greater correlation between exposure to airborne organisms in air from the kill department (Figure IX-1) than to conjunctival or skin contact with hog tissues or tissue fluids. Employees engaged in slaughtering and processing operations performed before deep tissues were exposed (Stage I Operations); in processing operations involving exposure to fresh raw tissue (Stage II Operations); or in other tasks requiring prolonged

Table IX-1

MOST PROBABLE SOURCE OF BRUCELLOSIS
BY OCCUPATIONAL GROUP OF PATIENTS, UNITED STATES, 1965-1974

	Occupational Group			
	Meat-Processing Industry	Livestock Industry	Other and Unknown	Total
Source				
Domestic Animals				
Swine	702	54	39	795
Cattle	121	179	52	352
Swine or Cattle	186	60	45	291
Sheep or Goats	7	5	6	18
Unspecified Farm Animals	57	4	2	63
Dogs	0	0	6	6
Wild Animals				
Caribou or Moose	0	0	12	12
Feral Swine	0	0	7	7
Deer	0	0	2	2
Unpasteurized Dairy Products				
Domestic	0	7	57	64
Foreign	0	2	125	127
Accidents				
Strain 19 vaccine	0	31	0	31
Laboratory	0	0	34	34
Unknown	0	12	233	245
Total	1,073	354	620	2,047
Percentage of Total	52.4	17.3	30.3	

exposure to the kill department (Mixed Operations), had the highest rates of seropositivity (Table IX-2).

In their review, Buchanan et al. noted all the major outbreaks of brucellosis that occurred in the period 1960-1972 were associated with swine slaughter (3). However, a resurgence of bovine brucellosis beginning in 1971-1972 made cattle the primary source of abattoir-acquired brucellosis by 1976.

POPULATION AT RISK

Of abattoir employees, kill department workers are at greatest risk of acquiring brucellosis. Although kill department workers constitute less than 20% of the approximately 150,000 abattoir workers in the United States, those with kill floor exposure have approximately 75% of the Brucella infections reported for abattoir employees. The multiple types of exposure to potentially contaminated animal tissues experienced by most kill department workers prevent the identification of the single "most" significant route.

PATHOLOGY

After they invade the body, brucellae localize in the bone marrow, lymph nodes, liver, and spleen. There they induce reticuloendothelial hyperplasia and the formation of small miliary granulomata. These have many similarities to the granulomata of sarcoidosis and miliary tubercu-

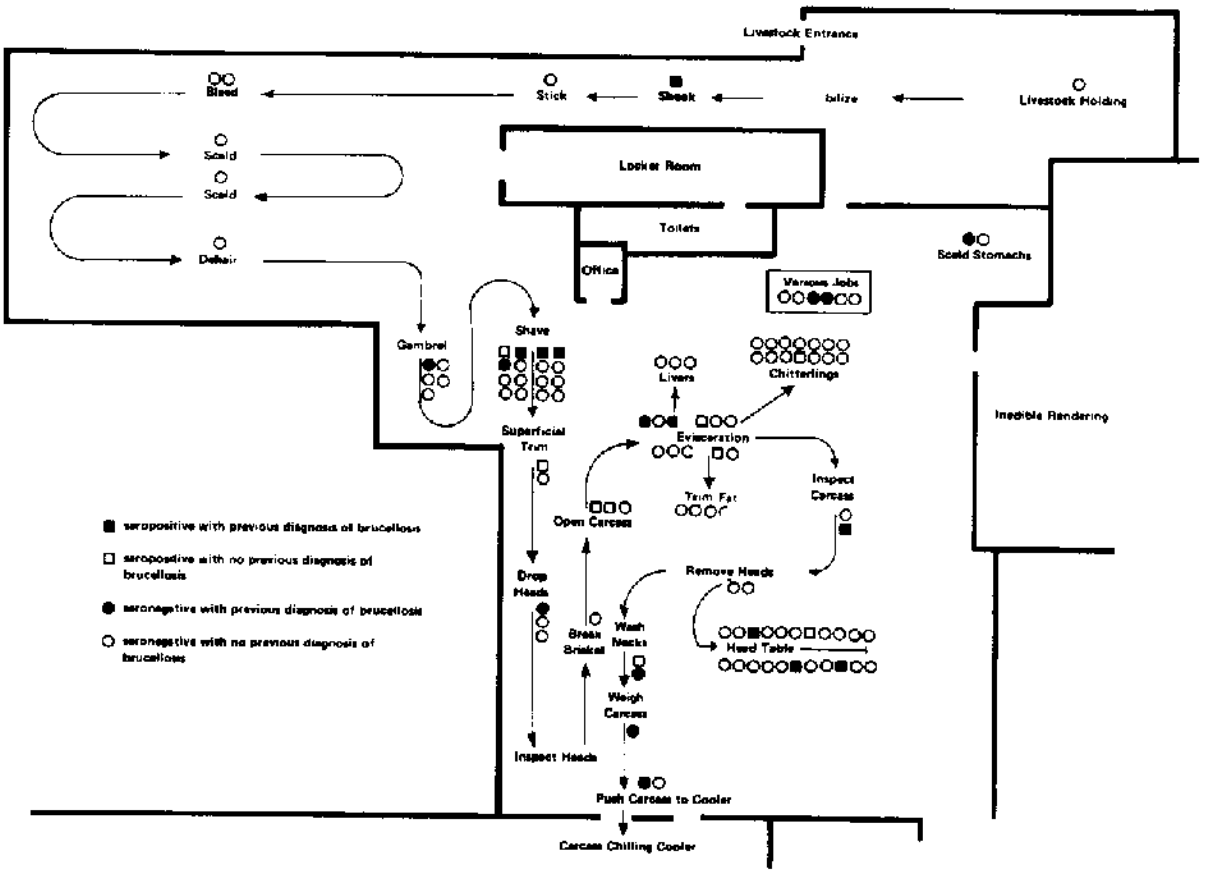

Figure IX-1. Hog Kill Department Employees by Work Location, Brucella Seropositivity and Previous History of Brucellosis, Smithfield, Virginia Packing Plant.

losis and consist of collections of macrophages and reticuloendothelial cells surrounded by a zone of mononuclear cells with some fibroblasts. Often there are giant cells. Rarely the center of the lesion may undergo necrosis with an associated polymorph infiltration, but typical caseation as seen in tuberculosis does not occur.

CLINICAL DESCRIPTION

Commonly reported symptoms of brucellosis include malaise, chills, sweating, weakness, body aches, headache, and anorexia. Clinical signs seen at physical examination include fever (either constant or intermittent), lymphadenopathy, and splenomegaly. Untreated, the illness may last for many months and can cause complications such as spondylitis, osteomyelitis, or endocarditis. Even with antibiotic therapy the patient may be ill for a month or more. Brucellosis is rarely fatal.

The treatment of choice for humans with brucellosis is tetracycline, 2 g daily by mouth for 21 days, with or without streptomycin, 1 g daily intramuscularly for 14 days. Buchanan et al. observed that patients treated with tetracycline and streptomycin had a lower rate of relapse than those treated with tetracycline alone or in combination with other drugs (2).

DIAGNOSTIC CRITERIA

Brucellosis can be definitively diagnosed by isolating the causative organism in culture. Blood is added to tryptase broth and incubated in an atmosphere containing 25% CO_2. The enrichment culture should be subcultured at four-day intervals and, if subcultures are negative, carried for a period of not less than three weeks. For subculture, agar plates of liver infusion or tryptase agar should be inoculated. Individuals suspected of being infected by *Brucella* microorganisms should have appropriate blood samples taken from cultures. Attempts to isolate the organism should be repeated several times before therapy is instituted since bacteremia may be intermittent. For patients with chronic brucellosis, cultures of blood, bone marrow, and other tissues may be productive.

Table IX-2

SEROPOSITIVITY BY WORK DEPARTMENT
SMITHFIELD, VIRGINIA — SEPTEMBER 1973

	Centrifugation Agglutination Test Titer>1:160			
	All Employees Surveyed		Excluding Employees in Departments Other Than Kill Who Previously Worked in the Kill Department	
Stage I Operation				
Kill Dept.	6/31	(19.4%)	6/31	(19.4%)
Stage II Operations				
Kill Dept.	11/81	(13.6%)	11/81	(13.6%)
Lard Rendering Dept.	2/7	(28.6%)	2/6	(33.3%)
Inedible Rendering Dept.	0/8	(0.0%)	0/8	(0.0%)
Total Stage II	13/96	(13.5%)	13/95	(13.7%)
Stage III Operations				
Cut Dept.	4/51	(7.8%)	4/41	(9.8%)
Conversion Dept.	0/5	(0.8%)	0/3	(0.0%)
Ham Boning Dept.	0/19	(0.0%)	0/14	(0.0%)
Bacon Slicing Dept.	0/21	(0.0%)	0/18	(0.0%)
Cure-Pump-Hang Dept.	0/11	(0.0%)	0/10	(0.0%)
Smoked Meat Packing Dept.	2/17	(11.8%)	0/14	(0.0%)
Sausage Packing Dept.	0/19	(0.0%)	0/14	(0.0%)
Sausage Chopping Dept.	0/4	(0.0%)	0/4	(0.0%)
Sausage Stuffing Dept.	0/6	(0.0%)	0/5	(0.0%)
Fresh Sausage Dept.	1/14	(7.1%)	0/10	(0.0%)
Total Stage III	7/167	(4.2%)	4/133	(3.0%)
Mixed Operations				
Maintenance Dept.	5/24	(20.8%)	3/20	(15.0%)
Miscellaneous Dept.	2/11	(18.2%)	1/7	(14.3%)
Total Mixed	7/35	(20.0%)	4/27	(14.8%)
NonProcessing Operations				
Delivery Dept.	0/28	(0.0%)	0/28	(0.0%)
Sanitation Dept.	0/4	(0.0%)	0/3	(0.0%)
Total NonProcessing	0/32	(0.0%)	0/31	(0.0%)
GRAND TOTAL	33/361	(9.1%)	27/317	(8.5%)

Brucellosis is commonly diagnosed serologically. The standard tube agglutination (STA) test is the most sensitive and widely used serologic test in the United States. Although this procedure involves using *Br. abortus* as antigen, it can be used to detect infections caused by *Br. melitensis*, and *Br. suis*, because all three have common antigenic determinants. *Br. canis* infection, however, can only be detected by using the specific antigen.

The 2-mercaptoethanol (2-ME) degradation test is used as an adjunct to the STA test. 2-ME, added to patient's serum before an agglutination test is performed, dissociates the IgM molecules so that any residual agglutination is caused by IgG antibodies. It has been found that the level of IgG remains elevated in persons with chronic brucellosis and disappears in those who are adequately treated. Thus the 2-ME test is particularly useful when low STA titers could indicate either current or past infection.

Both cholera vaccination and tularemia can falsely elevate STA titers (usually only minimally). The etiology of the elevated STA titer can be resolved by evaluating a clinical history or results of specific serological absorption studies.

Individuals suspected of having brucellosis, but whose culture and serologic results are negative pose a significant diagnostic problem. Of the several possible reasons for negative serologic results, the most important are 1) the prozone phenomenon, 2) the presence of blocking antibody in patient serum, 3) *Br. canis* infection in an individual whose sample was analyzed with an STA test in which *Br. canis* was not used as antigen, and 4) the disease is not brucellosis.

The problems of the prozone phenomenon and blocking antibody can be countered with specialized serologic techniques. Since prozone occurs only at lower serum dilutions, serial dilutions of serum samples should all be evaluated before the test is reported to be negative.

The presence of a blocking antibody is more difficult to prove than the prozone phenomenon, but it can be documented by using the Coombs test or centrifuging the reaction tubes before incubation.

PREVENTION

Although eye and skin protection should lower the risk of industrially related brucellosis, protective clothing and equipment commonly worn in abattoirs have apparently not been very effective. Metal mesh gloves protect against more serious cuts, but minor scratches and abrasions provide equally effective portals of entry for *Brucella* organisms. Rubber gloves should provide protection against contact exposure, but the gloves generally used do not cover wrists and forearms, and blood and other potentially infectious materials can enter the gloves through their open end and through accidental perforations. Where the conjunctival route of infection is important, ordinary eyeglasses have not been shown to provide protection.

Other than reducing unnecessary exposure to potentially infectious aerosols generated in the kill room, little can be done on a practical basis to prevent airborne or other transmission of brucellosis to abattoir workers. However, early diagnosis and appropriate therapy will reduce the duration and severity of the illness as well as the frequency of complications.

Only essential personnel should enter the kill room, which should be under negative air pressure in relation to other work areas. Employees should be instructed on how brucellosis is acquired, its symptoms, and the need for prompt diagnosis and therapy. Brucellosis should be routinely considered in the differential diagnosis of febrile illnesses in abattoir workers.

RESEARCH NEEDS

Surveillance of brucellosis and the epidemiologic study of specific problems dealing with abattoir-associated brucellosis should be continued. This is especially important where recommended control measures are of potential rather than proven benefit. Efforts to develop a safe and effective human brucellosis vaccine need to be continued, and vaccine use would probably be highly cost beneficial when administered to targeted populations such as abattoir or laboratory workers.

Further clinical studies dealing with safe and effective treatment of brucellosis are needed. New antibiotics such as trimethoprim-sulfonamide combinations must be thoroughly evaluated before they can be confidently recommended for treating patients with brucellosis.

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TUBERCULOSIS AS AN OCCUPATIONAL DISEASE

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DEFINITION

Tuberculosis is a communicable disease of man and animals caused by the bacterium *Mycobacterium tuberculosis* and, less frequently, *M. bovis.* Lesions most often occur in the lungs but may be found in any part of the body.

CAUSATIVE AGENTS

Species of *Mycobacterium* are characterized by unusual "acid fast" staining properties, slow growth, relative resistance to chemical disinfectants, and the ability to survive for decades within cells in the infected animal. Several species are known to cause human illness, but the virulence and communicability of *M. tuberculosis* make it by far the most significant human pathogen. With the exception of a comment in Research Needs, the information in this section pertains to *M. tuberculosis.*

LIST OF OCCUPATIONS AND INDUSTRIES INVOLVED

Tuberculosis is a contagious disease and can spread among individuals of any occupation. The few published studies of tuberculosis as an occupational hazard suggest that physicians, nurses, medical laboratory workers, and miners are at increased risk of tuberculosis (1)(3)(4). Other occupations presumably at increased risk are migrant workers, overseas personnel in any occupation, zoo employees, prison guards, and social workers and others who work with the impoverished and the derelict.

EPIDEMIOLOGY

Infection is almost always acquired via inhalation of contaminated microscopic particles generated by coughing, sneezing, speaking, or singing. Therefore, persons most likely to become infected are those with a prolonged exposure in a confined area to an infectious person.

In 1981, 27,373 cases of tuberculosis were reported in the United States for an annual incidence of 11.9 per 100,000 persons. The incidence is higher in older age groups, in nonwhite persons, and in males. The incidence is also high among immigrants, alcoholics, and prisoners, but sufficient data are not available to calculate specific rates.

Unfortunately, few studies of tuberculosis incidence among various occupations have been reported. Therefore, only general and somewhat unsatisfactory comments can be made about tuberculosis as an occupational hazard.

Doctors, nurses, and medical laboratory workers are at greater risk than the population as a whole because they care for persons with tuberculosis. Barrett-Connor recently estimated the infection rate of physicians was about twice that of the general population (1). Harrington calculated the disease rate of medical laboratory workers in England was above five times that of the general population (see Table IX-3) (3). Individuals who work with elderly persons, nonwhite persons, immigrants, alcoholics, or prisoners presumably are at increased (but unquantitated) risk of infection.

Miners and others who work in poorly ventilated areas are more likely to be infected by a fellow worker who has tuberculosis than are persons who work in well ventilated areas. Studies among different groups of miners show that the tuberculosis mortality rate ranges from approximately 1.5 times expected for coal miners to approximately 10 times expected for cummingtonite-grunerite miners (see Table IX-3)(4)(5).

ESTIMATE OF POPULATION AT RISK AND PREVALENCE OF DISEASE

Table IX-3 shows that between 1,099 and 4,784 persons have tuberculosis disease because they work in a medical or mining occupation. Un-