Johne’s Disease

USDA APHIS VS Career Services Program
Program Diseases Training Module

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This course is designed to provide updated information on the major domestic diseases for which Veterinary Services (VS) has program responsibility. It will provide information on surveillance, disease control and eradication for these diseases. It will also give an overview of the duties of a field Veterinary Medical Officer (VMO) as a support worker of VS animal disease programs and how they interact with other units in APHIS.

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1. **DISEASE INFORMATION**

**a. Agent**

Johne’s disease results from infection by *Mycobacterium avium* subsp. *paratuberculosis*, an acid-fast rod previously known as *Mycobacterium paratuberculosis* and *M. johnei*.\(^1\)\(^2\) Although Johne’s disease is mainly a disease of cattle, sheep, goats, deer, and other ruminants, infections can also be seen in a variety of non-ruminant species including rabbits, foxes, stoats, and birds.\(^1\)\(^3\) Horses, dogs, and non-human primates can be infected experimentally.\(^2\)\(^3\)

Some strains of *M. avium paratuberculosis* seem to preferentially infect specific hosts. The two main strains, which can be distinguished by restriction fragment length polymorphisms, are the C strain, found in cattle, and the S strain, found in sheep.\(^3\) The S strain seems to be confined mainly to sheep, but the C strain has a broad host range including cattle, goats, camels, and both ruminant and non-ruminant wildlife. Cross-species transmission of the S and C strains can occur between sheep and cattle, although this appears to be uncommon. Evidence also exists for a goat-specific strain in Norway and a unique strain in bison.\(^3\)

*M. avium paratuberculosis* is highly resistant to environmental conditions and can persist on pastures for more than a year.\(^2\)\(^3\) Sunlight, drying, and alkaline soils help to inactivate the organism.\(^2\) Viable bacteria have been found up to a week in bovine urine, up to 9 months in pond, tap, or distilled water, and up to 8-11 months in bovine feces.\(^3\)

**b. Transmission**

*M. avium paratuberculosis* is mainly transmitted by the fecal-oral route.\(^1\)\(^3\) Cattle can begin to shed bacteria in the feces before the onset of clinical signs. Shedding in asymptomatic animals is often intermittent; increasing numbers of bacteria are found as the animal becomes symptomatic.\(^1\)\(^4\) In cattle, *M. avium paratuberculosis* has also been isolated from the colostrum, milk, semen, embryos, and the male and female reproductive tracts including the uterus and testes.\(^3\) Transmission can occur on fomites.\(^3\) Flies have been implicated in mechanical transmission.\(^3\)

Animals are most susceptible to infection when they are young.\(^3\) Calves usually become infected when they nurse from an udder soiled with contaminated feces or are housed in contaminated pens.\(^2\)\(^3\) Calves may also be infected when they drink infected milk or colostrum.\(^1\)\(^3\) In one study, 3-19% of asymptomatic cows shed *M. avium paratuberculosis* in the milk and 9-36% in the colostrum.\(^3\) Up to 35% of symptomatic cows shed bacteria in the milk.\(^3\) *In utero* infections may also be seen. The estimated risk of fetal infection from culture positive cows is 26%, but may be much lower in asymptomatic animals that shed small numbers of bacteria.\(^3\) The importance of transmission in semen and embryos is unknown.\(^3\)

**c. Clinical signs**

Johne’s disease is a chronic, progressive disease; a long asymptomatic phase precedes the development of clinical signs. The incubation period ranges from 4 months to 15 years.\(^3\)

The first stage is a silent infection, found in calves, heifers, most immature young stock, and many adult cattle.\(^3\) At this stage, bacteria multiply within the walls of the small intestine.\(^1\) Depending on the animal’s resistance, it either eliminates the infection or becomes a healthy carrier.\(^1\) Subclinical disease, stage II, is usually seen in adults.\(^3\) In some stage II animals, the
bacteria begin to multiply again, resulting in extension of the lesions, interference with intestinal metabolism, and clinical disease (stage III). In cattle, symptomatic infections are not usually seen in animals less than 1-2 years old. Animals in stage III can progress to stage IV, advanced clinical disease, within a few weeks. A few animals can regress back to stage II and remain there for an indeterminate period.

In cattle, the main symptoms of paratuberculosis are diarrhea and wasting. The initial symptoms can be subtle and may be limited to weight loss, decreased milk production, or roughening of the hair coat. The diarrhea is usually thick, without blood, mucus, or epithelial debris, and may be intermittent at first. Tenesmus is not seen. The temperature and appetite are usually normal and animals are alert. Over weeks or months, the diarrhea becomes more severe and persistent, and intermandibular (“bottle jaw”) or ventral edema may develop. Affected animals become increasingly emaciated and usually die as the result of dehydration and severe cachexia.

The clinical signs are similar in other ruminants. In sheep and goats, the wool is often damaged and easily shed, and diarrhea is less common than in cattle. Clinical disease usually occurs at a younger age in sheep. In deer, paratuberculosis can be rapidly progressive. Intestinal disease has also been reported in rabbits and non-human primates.

d. Epidemiology

Johne's disease is seen mainly in ruminants. In the United States, the herd infection rate for dairy cattle has been reported as 24.2% in the Midwest, 23.5% in the West, 17.2% in the Southeast, and 16.1% in the Northeast. The prevalence of Johne's disease appears to be lower in beef cattle; 8% of U.S. beef herds were infected in one survey. Up to 31% of all zoos in the U.S. have also reported at least one case of Johne's disease. Worldwide, the prevalence of Johne's disease seems to be increasing.

Age-related resistance has been proven only in cattle; however, young animals are thought to be most susceptible to infection in all species. Most infections probably occur when young animals ingest bacteria on feces-contaminated udders or in their environment. Calves can also be infected when they drink infected milk or colostrum, and occasionally in utero.

*M. avium paratuberculosis* is usually introduced into the herd in an infected animal, and persists in breeding stock. Cross-species transmission of the S and C strains can occur, but seems to be relatively uncommon. Therefore, the greatest risk of infection for cattle appears to be from other cattle, and for sheep from other sheep. In a newly infected herd, the infection usually spreads for years before the first symptomatic cases appear. If no preventative measures are taken, the number of infected animals in the herd gradually rises and young animals are exposed to increasing doses of bacteria. When clinical cases are rare and occur mainly in older animals, the herd is probably only minimally infected. Symptoms in younger animals suggest that they were exposed to higher doses for longer periods of time. In herds where the organism is widespread, clinical signs can be seen in second- and first-calf cows, and even springers or bred heifers.

At any given time, only a small fraction of the infected animals in a herd are symptomatic. The percentage of carriers that develops clinical disease is unknown; however, once the symptoms appear, Johne's disease is usually progressive and fatal. Although the herd mortality
rate is only 1%, up to 50% of the herd can be asymptotically infected, resulting in losses in production.²

Although *M. avium paratuberculosis* has been isolated from a variety of wildlife, the significance of wildlife reservoirs for domestic animals is unknown.³ There is some limited epidemiologic evidence of natural transmission from wildlife, including red deer, to cattle and vice versa.³ *M. avium paratuberculosis* can also be experimentally transmitted between wild and domestic animals.³ In the United States, the only known foci of infection are in Rocky mountain bighorn sheep and mountain goats in Colorado, and in tule elk in California.³ Infections in other wild species or locations have not been completely ruled out.³

**e. Diagnosis**

Johne’s disease should be suspected in animals with chronic diarrhea and wasting, but can be confused with a number of other enteric diseases.³ Symptomatic cattle can be diagnosed by culture of the feces or tissues, PCR, fecal smears to detect acid fast bacilli, gross lesions, and histology.¹,³ Serology and tests of cell-mediated immunity can also be useful, but may be negative in advanced disease.³

Early “silent” infections (stage I) can only be detected by culturing *M. avium paratuberculosis* from postmortem tissues or, rarely, by histopathology.³ No routine live animal tests, including fecal culture and serology, can detect infected animals at this stage. In stage II (subclinical infection), some animals can be detected with fecal culture, serology, cell-mediated immune responses, PCR, pathology, or histology.¹,³,⁴

Vaccinated animals develop both humoral and cell-mediated immune responses.¹ The only useful tests in vaccinated animals are those that test for the organism.

**1) Tests to detect the organism:** Clumps of small, strongly acid-fast bacilli (but not single acid-fast bacteria) in the feces are suggestive of Johne’s disease.¹ Fecal smears are mainly useful in symptomatic animals.³ Organisms may also be found in smears from the intestinal mucosa or the cut surfaces of lymph nodes.¹

The “gold standard” for diagnosis of Johne’s disease is identification of the organism. Bacteria can be cultured from the feces, thickened areas of the intestinal wall, and ileal, mesenteric and ileocecal lymph nodes.³,⁸ *M. avium paratuberculosis* grows slowly and is greatly outnumbered by other bacteria in the feces; 5 to 16 weeks may be needed for isolation.¹,³ Fecal culture is almost always diagnostic in clinical cases.³ It is sometimes successful in asymptomatic animals, which may shed bacteria only intermittently.¹,³,⁴ In a herd, approximately 50% of the infected cattle can be detected by fecal culture.⁴ Sheep strains may not be easy to isolate; however, recent advances have made fecal culture more successful in this species.¹,³

DNA probes can detect *M. avium paratuberculosis* in feces or tissues and distinguish it from other species and subspecies of mycobacteria.¹ Although DNA probes are much faster than culturing the organism, they are not as sensitive and are quite expensive. The current tests are only able to detect infected animals when their infection has progressed to large numbers of *M. paratuberculosis* organisms being excreted in feces.
2) **Tests for cell-mediated immunity:** Cell-mediated immunity develops early in the infection and can be found in some asymptomatic carriers, but may wane or disappear as the disease progresses.\(^1,3,4\)

Intradermal testing with johnin or avian purified protein derivative tuberculin can detect delayed-type hypersensitivity (DTH) reactions to *M. avium paratuberculosis*.\(^1,3\) *In vitro* tests include a gamma interferon assay and a lymphocyte transformation test.\(^1,3\) Symptomatic animals may be negative in these tests.\(^1,3\) Exposure to other mycobacteria, including environmental saprophytes, can result in false positives.\(^1,3\)

3) **Serology:** Antibodies develop later than cell-mediated immunity, may be found in carriers, and tend to increase in titer as the intestinal lesions become more extensive.\(^1\) Serology is not usually recommended for animals less than 15 months old, as humoral immunity generally develops 10-17 months after infection.\(^3\) Antibody production can decrease late in the course of the disease.\(^3\)

Serology can be used for the presumptive identification of infected animals, estimates of the prevalence of infection in a herd, and confirmation of Johne's disease in animals with clinical signs.\(^3\) Serology is not particularly good at detecting subclinically infected animals.\(^3\) In cattle, the only tests that are widely used in the U.S. are enzyme-linked immunosorbent assays (ELISAs), and agar gel immunodiffusion.\(^1,3\) An ELISA has been developed for milk and bulk milk samples, but its sensitivity is still unknown.\(^3\) Complement fixation is used only when required for international export.

4) **Gross lesions and histopathology:** In cattle, the characteristic lesion is a thickened, often corrugated, wall in the distal small intestine, sometimes accompanied by enlargement of the mesenteric lymph nodes and other regional nodes.\(^1,3\) Discrete plaques may be seen early in the disease; these plaques can sometimes be detected by holding the intestine up to a light source.\(^1\) The earliest lesions occur in the walls of the small intestine and the draining mesenteric lymph nodes.\(^1\) In more advanced cases, the lesions can extend from the duodenum to the rectum.\(^3\) Common secondary changes include a thin or emaciated carcass, effusions in the body cavities, and dependent subcutaneous edema.\(^3,2\) Gross lesions are usually absent in stages I and II.\(^3\)

Similar lesions are seen in sheep and goats.\(^1,3\) The mucosa is often only slightly thickened in these species, but caseated or calcified nodules are sometimes found in the intestines and associated lymph nodes.\(^1,2\) Some strains of *M. avium paratuberculosis* produce a pigment that stains the intestinal lesions brownish-yellow or yellow-orange.\(^2,3\)

Histologic changes and bacteria may be found in the intestinal lining and in the ileal, mesenteric, and ileocecal lymph nodes.\(^8\) Multiple samples may be needed for a diagnosis.\(^1\) Infiltration of the lamina propria, Peyer's patches, and the cortex of the mesenteric lymph nodes with large, pale-staining epithelioid cells and multinucleated Langerhans' giant cells, with clumps or singe acid-fast bacilli, is pathognomonic.\(^1\)
f. Prevention and control
Many more animals are infected asymptomatically with *M. avium paratuberculosis* than develop clinical signs; Johne’s disease is, therefore, usually a herd problem rather than a disease of individual animals. Infected herds can be identified by herd testing with serology or fecal culture. Without herd testing, infected herds may be missed due to lack of producer awareness, the poor sensitivity of the diagnostic tests in individual animals, and the similarity of the symptoms to other diseases.

To keep from introducing Johne’s disease into a herd, farmers should buy replacement animals from test-negative herds with good records and management practices. Herds that have been free of Johne’s disease for the last 5 years may also be an option. Vaccines can decrease the severity of symptoms and the bacterial load but do not prevent infection or the shedding of bacteria. Only a killed product vaccine is used in the U.S.

Once Johne’s disease has entered the herd, the basic control techniques are 1) to prevent young animals from becoming infected by decreasing their exposure to infectious manure, colostrum, and milk and 2) to decrease exposure in the herd by culling infected animals. Symptomatic animals, in particular, should be isolated and culled as soon as possible. Test and slaughter procedures, based on serology or fecal culture, can reduce the prevalence of infection but may not be successful unless there are also management changes to reduce transmission within the herd.

Manure management and disposal are important risk factors for Johne’s disease. Contamination by *M. avium paratuberculosis* can be minimized by preventing manure build-up. Tuberculocidal (phenolic or cresylic base) disinfectants can be applied after the manure is removed. Calves should be kept from contact with the manure from adult cattle, including forage from fields fertilized with manure from the adults.

Removing newborn calves from the dam before nursing decreases the within-herd prevalence of infection. In a dairy herd, cows should calve in clean, dedicated maternity pens and the calves should be reared separately from the adult herd for at least the first year. The calves should be fed colostrum collected from low-risk or negative cows with cleansed and sanitized udders, then fed only milk replacer or pasteurized milk.

*M. avium paratuberculosis* is difficult to destroy. It may survive drinking water treatments, including chlorination, and also seems to survive pasteurization in some cases. Its ability to survive various techniques for cooking meat is unknown.

g. Public health consequences
Some data suggest that *M. avium paratuberculosis* may be involved in Crohn’s disease. Crohn’s disease, a chronic inflammatory enteritis of humans, is characterized by periods of malaise, abdominal pain, chronic weight loss, and diarrhea, with remissions and relapses. The disease often begins between the ages of 16 and 25 years, and persists lifelong. It can be complicated by perforations, abscesses, fistulas, intestinal obstruction, and strictures. There is no cure.

The cause of Crohn’s disease is not known; however, it is thought to be the result of several interacting factors, including a genetic predisposition, an abnormal immune response, and environmental factors which may include responses to intestinal microorganisms. It is possible
that Crohn’s disease has a variety of causes rather than a single cause. The data linking *M. avium paratuberculosis* to Crohn’s disease are controversial and remain to be confirmed. **M. avium paratuberculosis** can be found in some patients with Crohn’s disease; however, isolation is rare and studies to date have not been able to determine whether this organism has a causative role or is simply an “innocent bystander” that can grow in the inflamed intestinal wall.

The Johne’s disease vaccines can cause severe local reactions, including sloughing of tissues, chronic synovitis, and tendonitis, if they are accidentally injected into humans. Some cases may require surgery.

### Economic Impact

The economic impact of Johne’s disease is difficult to determine, as most infections are subclinical and the prevalence of infection is not fully known. In the United States, estimates of annual losses include $15.4 million in New England, $54 million in Wisconsin, $5.4 million in Pennsylvania, and approximately $200-250 overall in U.S. dairy herds. A 1996 National Animal Health Monitoring System (NAHMS) study in U.S. dairy herds estimated that, in a herd with Johne’s disease symptoms in less than 10% of the cull cows, the estimated annual value of production was $40/cow lower than in Johne’s negative herds. In herds with Johne’s disease symptoms in 10% or more of the cull cows, the annual economic impact was estimated at $225/cow. Other estimates, some based on models, have varied from $22-$27/cow per year.

Most of the economic losses from Johne’s disease are thought to be from decreased milk production. Subclinical carriers are estimated to produce 15-16% less milk, with losses of 1,300-2,800 pounds of milk per lactation. Other losses occur from increased morbidity and mortality, increased treatment costs, decreased value of animals at slaughter, decreased reproductive and feed efficiency, losses from idle production facilities, and unrealized future production from early culling.

### History of the Disease and Control Programs

The first reports of a chronic, debilitating intestinal disease of cattle appeared in the 1820s but it was the late 1800s before the causative organism was first described. In 1894, Drs. H.A. Johne and L. Frothingham, of the Veterinary Pathology Unit in Dresden, Germany, first observed *M. avium paratuberculosis* in the intestinal tissues from a sick cow. By the early 1900s, this disease - called paratuberculosis, hypertrophic enteritis, pseudotuberculous enteritis, or Johne’s disease - was known to be widespread and there were early warnings of its potential impact on animal agriculture in the U.S.

Attempts to diagnose and control Johne’s disease were hampered by difficulties in growing the organism and developing good diagnostic tests. An intradermal skin test, using antigens prepared from *Mycobacterium avium*, was developed in the early 1910s. However, the Johne’s organism, unlike *M. avium*, remained impossible to culture until the British scientist F.W. Twort discovered that it required growth factors from other bacteria. In 1912, Twort found small bacterial colonies growing around contaminants of the common hay bacillus, *Mycobacterium phlei*, in old cultures he was discarding. By incorporating a heat-killed preparation of *M. phlei* into his culture medium, Twort was able to grow the Johne’s organism, which he called
Mycobacterium enteritidis chronicae pseudotuberculosa bovis Johne. This development led to new diagnostic tests, including complement fixation, agglutination, and a refined skin test with a preparation called “johnin.” In spite of these advances, the long incubation period time required for culture continued to complicate diagnosis.

In 1951, the U.S. Department of Agriculture warned “Johne's disease may become very prevalent and troublesome in the United States unless more attention is given to its diagnosis and control.”9 Numerous attempts were made to develop vaccines in the 1950s, but none of the vaccines could prevent infection or shedding of bacteria.3,9 New diagnostic tests, including leukocyte migration and fluorescent antibody tests, appeared in the 1960s.9 In 1989, the discovery that M. avium paratuberculosis contains a unique genetic element, an insertion element called IS900, led to the development of new genetic tools to detect the organism directly.9 This discovery, as well as the development of other diagnostic tools including the ELISA, agar gel immunodiffusion, and gamma interferon tests, provided new tools for Johne's disease control programs.9 During the last few decades, Johne's disease seems to have become more prevalent worldwide, prompting increased concern about the costs of this disease.3 The zoonotic potential of Johne's disease also became an issue in the 1990s when M. avium paratuberculosis was associated with some cases of Crohn's disease.9

National programs to control Johne's disease and recognize disease-free herds were first developed in Australia and the Netherlands.3,9 In the United States, the control of this disease has historically been left to the individual states. Some states have had independent voluntary programs for many years; others had no control program.3 In 1993, the National Johne's Working Group, a special committee of the U.S. Animal Health Association (USAHA), created a Voluntary Johne's Disease Herd Status Program for cattle, modeled after the Dutch and Australian programs.3,9 USAHA also set up an accreditation program for laboratories that test for Johne's. USAHA's first voluntary program was adopted by some states but few herd owners participated, citing the amount of testing and its associated costs.10 As a result, USAHA developed a new voluntary program, with input from numerous groups including veterinarians, cattle breed associations, and industry groups.3,10 This program, which USAHA released in 1998, has been adopted by a number of states. In 2002, USDA-APHIS released the Uniform Program Standards for the Voluntary Bovine Johne's Disease Control Program, to help states establish Johne's disease programs and to promote more uniform state programs.3,11,12 The test-negative component of this program mainly comprises the USAHA Voluntary Herd Status program. The test positive component is expected to be a foundation for future control efforts by APHIS.11

A voluntary Johne's indemnity plan, the National Voluntary Johne's Management, Testing, Research, and Indemnity Program for Dairy Cattle, has also been proposed.11 This program would also be administered by the states, with accountability at the federal level. All adult cattle in the herd would be tested under this plan, and all pregnant cattle would be tested monthly on a “rolling” basis. Culture-positive animals would be marked; heavily infected cattle would be sent for rendering and other culture-positive animals for slaughter. A research component of the plan would concentrate on the development of a better vaccine and diagnostic tests.

In addition, the National Milk Producers Federation (NMPF) lobbied for a federally funded program that provides reimbursement for producers with Johne's disease-related expenses who have an approved Johne's disease management plan.3 The goals of the NMPF program are to encourage voluntary testing of herds for Johne's disease and the establishment of herd
management plans. Other U.S. livestock industries are also considering certification and control programs. The American Zoological Association has published Johne’s disease guidelines.

3. CURRENT CONTROL PROGRAM

The three elements of the voluntary Johne’s disease program consist of 1) producer education about disease costs and management strategies, 2) assistance to producers in establishing good management strategies, and 3) herd testing. Producers who participate in the educational element can also choose to participate in the management or the herd test testing elements.

a. Education
Producers enter the state programs at the education element. Either group workshops or one-on-one sessions with the producer’s veterinarian are acceptable, but records should be kept of participation. Producers should receive basic Johne’s disease information, information on management strategies to control and eliminate the disease, and information on the state program.

b. Management
In the management element, producers put approved management practices into place. Producers who have their herds tested for Johne’s disease can participate in either the management or the testing elements; producers can also participate in the management element without testing.

In the first step of the management element, a Johne’s certified veterinarian or animal health official conducts a risk assessment, to evaluate the management practices likely to spread M. avium paratuberculosis in the herd. Together with the producer, he or she develops a herd management plan. The purpose of the herd plan is to prevent the introduction of Johne’s disease into the herd and to reduce its transmission within the herd. Copies of both the risk assessment and the individual herd plan must be submitted to the designated Johne’s coordinator (DJC) for the state, for review and final approval.

Participating herds must abide by the program’s regulations and management requirements. All cattle in participating herds must be individually identified. APHIS recommends an official eartag, but any state-approved method is allowed. Minimum biosecurity measures designed to keep new infections off the farm include buying new animals only from low-risk or known-status herds and from known sources. Animals should not come from sale yards. Animals with symptoms of Johne’s disease should be separated from the rest of the herd and diagnosed as soon as possible. Culture-positive animals should be sent to slaughter or rendering. The contamination of feed, water, equipment, and vehicles by manure from all animals should be minimized.

Young stock should be exposed as little as possible to the manure of older animals, including all species susceptible to Johne’s. In dairy herds, the minimum management practices include maintaining a separate clean, dry maternity area for calving, and separating newborn calves immediately from all adult animals. Newborn calves should be fed colostrum from a single, test-negative or healthy low-risk cow, which should be identified in the records, and are never
Calves must be housed by age, fed milk replacer or pasteurized milk, and kept from exposure to manure from adult animals.

In beef herds, the minimum management practices include keeping the calving areas as clean and dry as possible, and minimizing the density of cow and calf pairs. Newborn calves can receive colostrum either from the calf’s dam or from another test-negative or healthy, low risk cow; pooled colostrum should not be used. Weaned calves that will be herd replacements should be raised separately from older animals. Feeding practices should be designed to reduce the contamination of feed and feeding areas by manure.

Herds that continue to participate in the program must have an annual risk assessment by a Johne’s certified veterinarian and the herd owner must make any necessary changes to the herd management plan. The updated risk assessment and herd management plans are submitted each year to the DJC.

c. Herd testing

The third program element, herd testing, publicly recognizes producers who put approved management practices into place, and separates test-negative from test-positive herds. Herds in the testing element must continue to meet the requirements of the management element.

To enter the testing element, a herd must have a risk assessment, a herd management plan, and a herd test for Johne’s disease. The herd test includes at least 30 randomly selected cows, at second lactation (3 years old) or higher. If the herd has fewer than 30 second-lactation cows, first-lactation animals (2 years old) are also included. The herd owner is encouraged to test a statistical subset of the herd. Either a screening test or an official Johne’s disease test may be used in most herds; however, if the herd is vaccinated, an official test must be used. The screening test currently approved by the USDA is the ELISA. Official Johne’s disease tests identify the organism and include fecal culture, culture of tissues, DNA probes, and histology.

Animals that are positive on screening tests are considered to be suspects until they have an official test, or until they develop symptoms of Johne’s disease. The owner may choose to have suspects retested with an official Johne’s disease test within 45 days. If the official test is negative, the herd can be classified as test-negative, but the suspects must be included in the next round of screening. The results of an official test can only be appealed by 1) euthanasia and necropsy of the animal, with culture and histopathology of the ileum and mesenteric and ileocecal lymph nodes, 2) biopsies of the ileum and mesenteric or ileocecal lymph nodes, with culture and histopathology, and a fecal culture, or 3) six fecal cultures, collected every 30-45 days. All six fecal cultures must be negative to classify an animal as negative. Tests to appeal an official test are done at the herd owner’s expense.

All tested animals must be negative, for the herd to enter the test-negative component. A herd that tests positive can either remain in the management element or be enrolled in the test-positive component.

a) Test-positive component: States can use the test positive component to monitor infected herds. The herd owner must sign an agreement to abide by the minimum biosecurity, management, and testing requirements of the program. Any animals added to the herd must
come from another herd with an approved herd management plan. The program recommends that test-positive animals be restricted to the premises or go directly to slaughter or rendering.

Participating states may use optional assessment levels, from A to D, in the test-positive component. Herds in level A have the lowest prevalence of disease, and herds in level D the highest. Herds with one or more positive animals, among the 30 second-lactation cows tested, are classified as level D. A herd is also classified as level D if more than 15% of the animals in a whole herd test, including all bulls over 2 years old, are positive in screening or official tests. A level C herd contains 5-15% test-positive animals in the whole herd test, and a level B herd less than 5%. Level A herds contain no test-positive animals. To enter level A, the herd must either test 30 randomly selected second-or higher lactation cows, or do a whole herd test. To remain in level A, the herd must re-test 30 second-or higher lactation animals every 10 - 14 months. Level A herds can enter the test-negative program at Level 1.

The year the herd achieves the level is also included in its status. A Level B 2001 status, for instance, indicates that the herd achieved Level B in 2001 and has remained in that status.

Test-positive herds must be re-tested for Johne’s disease every 10-14 months. To continue in the test-positive component, the herd owner must submit a copy of the new test results, an updated herd management plan, and an agreement to follow the test-positive component requirements. If the animals are not re-tested, the herd is returned to the management element of the program.

**b) Test-negative component:** To enter the test negative component, the herd owner must sign an agreement to abide by the minimum biosecurity, testing, and management requirements of the program. Vaccinated test-negative herds are eligible if they discontinue vaccination.

The test-negative component contains a series of levels, from 1 to 4; herds in higher levels are more likely to be free of Johne’s disease. Level 1 herds have a herd management plan and a negative herd test on 30 cows. To enter Level 2, 3, or 4, a statistical subset of animals must be tested. Each test must be done within 10-14 months of a test for the previous level. Level 2 requires a screening test on second-lactation and older cows, level 3 requires fecal cultures on these cows and any bulls that are at least 2 years old, and level 4 requires another screening test on the cows. To continue in any level, the herd only needs a negative screening test on at least 30 second-or higher lactation cows every 10 to 14 months. The year the herd achieves the level is also included in its status. No level certifies that the herd is Johne's free.

In the standard track, herds can reach Level 4 in a minimum of 3 years and four tests. The fast track allows the herd to skip Level 1. A herd can enter the fast track if the herd owner signs a declaration that no cows have had Johne’s disease or its symptoms in the past 5 years, and no new cattle have been introduced to the herd within the past 5 years. Herds in the fast track proceed through levels 2-4 in the same steps as herds in the standard track.

Animals can be added to test-negative herds, without testing, if they are from another test-negative herd with the same or a higher status. Animals can also be added from herds of unknown or lower status if they meet certain age-based requirements. Once they are at least 2 years old, these animals must also be included in the next herd test. If a heifer or bull less than
2-years old is added, the only requirement is that the animal be tested in the next herd test; however, the herd is restricted to Level 1 until all additions are old enough to be tested. If the animal is 2-years old or older, and is entering a Level 1, 2, or 3 herd, it must be negative on a screening test within the 30 days before it enters the herd. A fecal sample must also be submitted for culture within the 30 days before or after the animal is added to the herd. Two-year old and older animals can be added to a Level 4 herd from a Level 2 or 3 herd with these same requirements.

Test-negative herds can use any semen processed according to Certified Semen Services’ standards and any embryos processed according to the International Embryo Transfer Society’s protocols. Any cows that receive embryos must meet the same requirements as herd additions.

In test-negative herds, any suspects found on screening tests are retested with an official test. If positive animals are found in an official test, the herd is either placed in the test-positive component or the management level. In vaccinated herds, an official Johne’s disease test must be used until enough unvaccinated natural additions qualify for serology. Each year, the herd owner must submit a copy of new test results, an updated herd management plan, and an agreement to follow the test-positive component requirements.

4. CONTROL PROGRAM STATUS

As of March 2003, all U.S. states except Alaska, Arkansas, Guam, Louisiana, Massachusetts, Montana, Nevada, Puerto Rico, Rhode Island, and Wyoming had Johne’s advisory committees. Committees were also in the planning stages in Louisiana, Nevada, Puerto Rico, and Wyoming. Thirty-one states had state control programs and 35 states had adopted the test negative Johne’s herd status program. Most participating states had both programs; these states include Alabama, California, Colorado, Connecticut, Florida, Georgia, Hawaii, Illinois, Indiana, Kentucky, Maine, Michigan, Minnesota, Mississippi, New Jersey, New York, North Carolina, North Dakota, Ohio, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Vermont, Virginia, Washington, and Wisconsin. Delaware, Missouri, Nebraska, Oklahoma, Rhode Island, and Utah had herd status programs but no control program. Idaho and Maryland had control programs but no herd status program. Herd status programs were in development in Idaho, Kansas, Louisiana, and Puerto Rico.

As of 2002, 471 U.S. cattle herds were in Level 1, 80 herds in Level 2, 25 herds in Level 3, and 55 herds in Level 4. By 2002, approximately 600,000 herds had been tested by ELISA, and 98,000 by fecal culture. The number of laboratories approved for Johne’s disease testing is also growing. In 2000, only 16 laboratories had been approved for fecal culture and two laboratories for Johne’s PCR. As of February 2003, approved PCR laboratories existed in 8 states and approved fecal culture laboratories in 21 states, with 2 or 3 approved laboratories in several states.

a. Surveillance

The 1996 National Animal Health Monitoring System (NAHMS) study in U.S. dairy herds found that the herd infection rate with M. avium paratuberculosis was 24.2% in the Midwest, 23.5% in the West, 17.2% in the Southeast, and 16.1% in the Northeast. Approximately 8% of beef
herds were found to be infected. The test positive component of the voluntary Johne's disease program is also used by states to monitor some infected herds.

Relatively few producers feel they are knowledgeable about Johne’s disease. In the 1996 NAMHS study, 10% of dairy farmers had never heard of Johne's disease, 35% only knew the name of the disease, 37% knew some basic information about the disease, and only 18% considered themselves to be knowledgeable.

There is no requirement for pre-movement Johne’s disease testing in animals moved interstate. However, animals known to be positive on an official Johne’s disease test (any test which detects the organism) cannot be moved across state lines except to slaughter. These animals must be identified with an official eartag and moved to the slaughterhouse without unloading. With special permission, Johne's disease positive animals may be allowed to move interstate for other purposes. No federal restrictions currently prohibit the movement of Johne’s disease positive animals within a state. No states currently require testing for Johne’s disease before entry, although some state regulations broadly prohibit entry of animals with contagious diseases.

Johne's disease (paratuberculosis) is a World Organization for Animal Health (OIE) list B disease. The OIE code requires than animals have no symptoms of Johne’s disease on the day that they are shipped, be tested for Johne's disease within the 30 days before shipment, and come from a herd that has had no sign of Johne’s disease for the past 5 years. Given the weaknesses of the current diagnostic tests and the long incubation period for Johne's disease, these requirements cannot guarantee that an animal is Johne’s free.

5. ROLE OF THE VMO IN THE JOHNE’S PROGRAM

a. Testing
An accredited veterinarian or a state or federal animal health official must collect (or supervise the collection of) all samples from Johne’s disease herd tests. The samples must be submitted to an approved Johne’s disease laboratory. Laboratories are certified to test for Johne’s disease with test kits provided by the National Veterinary Services Laboratories (NVSL).

The screening test approved by the USDA is the ELISA. This test can also be used to help make management decisions. The sensitivity of the ELISA is estimated at 25% in asymptomatic animals and 85% in clinical cases. The specificity of this test is 98-99%. Animals that are positive in an ELISA are considered to be suspects until their status is clarified with an official Johne’s disease test.

The official Johne’s disease tests include fecal culture, tissue culture, DNA probes, and histology. The sensitivity of both culture and DNA probes are estimated to be approximately 40%, with a specificity of 99-100%. DNA probes can provide results within 3 days, but these tests are more expensive and may miss cattle that shed few organisms. The sensitivity of histology varies with the stage of disease and the samples collected but is generally thought to be higher than the other tests.
b. Control programs
APHIS helps coordinate the establishment of Johne’s disease programs by the states, and also provides expertise to the states. APHIS also works with state and industry representatives in the USAHA National Johne’s Working Group.

The “Uniform Program Standards for the Voluntary Bovine Johne's Disease Control Program,” published by USDA-APHIS, establishes uniformity among the many state Johne’s disease programs. The test positive component of the program is expected to be a foundation for future control efforts by APHIS Veterinary Services. The test-negative component mainly comprises the Voluntary Herd Status program endorsed by USAHA.

c. Other duties
VMO personnel are also involved with education activities such as participating in producer and veterinary education programs, conducting Johne’s risk assessments, and working with producers and the herd veterinarian to develop Johne’s herd management plans.

6. ROLES AND RESPONSIBILITIES OF THE FEDERAL GOVERNMENT, STATES, INDUSTRY AND PUBLIC HEALTH OFFICIALS

The voluntary Johne’s disease programs are administered by the individual states and supported by industry and the federal government. Participating states must establish a Johne’s disease group to assist in program development, implementation, and review. This group should include dairy and beef producers, university and extension faculty, diagnostic laboratory personnel, regulatory veterinary medical officers, and veterinary practitioners.

States can use private practitioners, as well as state or federal personnel, to conduct risk assessments, develop herd management plans, and collect and submit test samples. These veterinarians, called Johne’s certified veterinarians, are accredited veterinarians who have received additional education on Johne’s disease. Johne’s certified veterinarians must be trained to conduct risk assessments and herd management plan. They must also understand the epidemiology of Johne’s disease, Johne’s disease tests and test interpretation, and the state and federal requirements of the program. Johne’s certified veterinarians must take a Johne’s disease refresher course at least once every 3 years.

The designated Johne’s coordinator (DJC) for the state interprets laboratory results to classify animals and herds, provides training for and monitors state personnel and Johne’s certified veterinarians, and reviews risk assessments and herd management plans. The DJC also assists owners and program personnel in developing herd management plans, as necessary. The DJC provides a quarterly progress report to the APHIS Veterinary Services regional Johne’s disease epidemiologist and Johne’s staff, and audits the state’s Johne’s program periodically to determine its effectiveness. In addition, the DJC is a member of the state Johne’s Disease Group.
7. REFERENCES


