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subject to abuse.

Practically all of the recent texts in pharmacology and therapeutics contain at least one chapter relating specifically to drug abuse and these sources are recommended as starting points. Ask in your local community about ongoing programs and they will greatly appreciate your help. In particular, younger people will be of great help to you, through such organizations as the Boy Scouts of America, Girl Scouts of America, church youth groups, etc.

Here at Iowa State, students of veterinary Medicine from the sophomore, junior, and senior classes are working to prepare a desk reference on drugs of abuse for use by the DVM. In addition, they are preparing themselves to go out as resource people working with the author in a student-teacher relationship as he discusses drug abuse issues with different groups. While the problem of drug abuse isn’t really new, maybe some answers will come from new people becoming involved.

The Trichiniasis Problem: Facts, Fallacies, and Future
by W. J. Zimmermann, Ph.D.*

Using adaptability to hosts and historical implications as criteria, Trichinella spiralis must be one of the oldest of disease producing organisms. Development of adaptability to hosts by a parasitic agent is regarded as a slow, evolving process. Natural host records for trichinae have been reported for over 100 species, with probably all mammals being susceptible to infection with this parasite. In contrast, most other parasites are host specific, being infective to only one or a limited number of related host species. Historically, even though T. spiralis was not recognized as a disease entity in man until 1835 and in swine until 1846, trichiniasis is regarded as a possible reason for the admonition of the Mosaic law against eating pork.2

The interrelationships of the disease in man and swine have been studied by thousands of researchers dating back to Virchow in the mid-1800’s. Virchow was the first to advocate compulsory microscopic examination of pork. Two anecdotes told about Virchow are of interest. In addition to being an eminent pathologist, he also served as a leader of the Reichstag. As such he was challenged to a duel by Chancellor Bismarck. Having the choice of weapons, Virchow chose two sausages—one containing trichinae. The Chancellor abruptly withdrew his challenge. Another time he was advocating compulsory microscopic pork inspection. A veterinarian challenged the need for this. Upon heckling from those in attendance, the veterinarian ate raw pork. Five days later, he became ill, presumably from trichiniasis.

Even with all the attention given to

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trichiniasis, the problem still persists. Any progress which has been made in the reduction of the problem in the U.S. resulted indirectly from side effects of other programs or developments. These include the vesicular exanthema and hog cholera eradication programs, development of swine management and feeding programs, widespread use of freezing for storage of pork, and decrease in non-inspected pork processing.

The pork industry of the U.S., after ignoring the problem for over a century, became cognizant of the problem and its effect on marketing in 1966 and requested the development of a trichina elimination program. The USDA has now formulated a program proposal which soon will be presented to Congress. The leadership of the veterinary profession will be essential to the success of this program if it is approved.

Parallel to the virtual inattention given to the problem in the U.S., certain fallacies have risen regarding the problem. These concern public health significance, extent and type of animal involvement, and need for specific control programs. This report will briefly assay the problem, past, present, and future in an attempt to clarify understanding of the problem, especially as it relates to the veterinary profession. The trichiniasis research program carried out at the Veterinary Medical Research Institute (VMRI) since 1954 will serve as a basis for much of the review.

Public Health Aspects

The trichiniasis problem in humans of the U.S. has decreased markedly in recent decades. Studies by the National Institutes of Health during 1936–41 revealed that 16.1% of 5,313 cadavers had been infected with trichinae during their lifetime. Adjustment for age distribution of the sample reveals that 12.2% of the population, or nearly 16 million individuals were infected during that period. About 45% of these infections contained living trichinae, indicating relatively “recent” infections.

The problem today is much less. A similar national study carried out by the VMRI (in part unpublished) revealed a prevalence of only 4.1% for 8,071 human diaphragms examined during 1966–70. When adjustment for age again is made, the prevalence on a total population basis is 2% indicating that about 4 million humans in the U.S. have detectable trichina infections. Only 14% of the infections contained living trichinae, thus about 600,000 individuals currently have recent infections.

Some of the other current epidemiologic characteristics are also of interest. Risk increases with age as individuals 45 years or older have a prevalence of 4.8% compared to only 1.8% for those under 45 years. The rates for those of Italian and German extraction are nearly 2.5 times the national average, related to their propensity for raw sausage.

Another indicator of a decreasing problem is the decline in reported human cases. While an average of nearly 400 cases per year was reported in the 1940’s, only an average of about 115 cases per year was reported in the 1966–70 period. These figures must be regarded as minimal since the signs and symptoms of the disease are so diverse that many cases are not diagnosed.

The decrease of the problem in humans closely parallels changes in the infective rate for swine. Studies by the USDA revealed a prevalence of 0.95% in farmed-raised swine during the 1930’s and 0.63% during 1948–52. National swine studies were initiated at the VMRI in 1961. A prevalence of 0.12% in butcher swine and 0.22% in breeder swine was obtained in a 1961–65 study. A recently completed apportioned study (unpublished) revealed a similar prevalence, 0.125%, for butcher swine but dissimilarities in other epidemiologic factors may indicate an upswing in the problem. These include: a prevalence rate of 0.33% was found in 1970, the highest yearly rate of the decade; the problem is now concentrated in the north central region, where most of the nation’s swine are raised; infections are heavier, as indicated by increased trichina per gram counts; and more herd involvement is indi-
cated.

The prevalence in garbage-fed swine has similarly declined. During 1950, a prevalence rate of 11.2% was obtained in raw garbage-fed swine. Then with the outbreak of vesicular exanthema, most states instituted garbage cooking regulations during 1953–54. The prevalence then declined to 2.2% during 1954–59. Studies at the VMRI during 1961–65 gave an overall rate of 2.6% but indicated a rate of about 5% during 1961 which declined to only 0.5% during the latter part of the study. The high rate in 1961 possibly reflected a laxity in cooking procedures following eradication of vesicular exanthema in 1957. Then with initiation of the hog cholera eradication program in 1962, the prevalence again declined rapidly. A statistically designed study in 1964–66 confirmed the 0.5%. This has remained constant in the recently concluded VMRI study.

For years it has been assumed that if commercial garbage-feeding establishments were eliminated the trichiniasis problem would be solved. This is not a valid assumption. Currently it is estimated that over 100,000 infected farm-raised swine are marketed yearly compared to only about 6,000 garbage-fed swine.

Since garbage feeding of swine in Iowa has been minimal and is now banned, brief mention should be made of findings in man and swine. Studies for humans of Iowa during the 1960's revealed trichinae in about 3% of the diaphragm samples examined. The prevalence in swine declined from 0.16% during 1953–57 to 0.065% during 1966–70 (unpublished). Even at this low rate, over 13,000 infected swine are marketed yearly from this state (about one-eighth of the nation's total).

The marked decrease in prevalence for both man and swine would tend to indicate that trichiniasis is no longer a public health problem. This is not true. Major outbreaks can and do occur. Outbreaks in the midwest during the past decade include: Iowa, 1961, 18 cases; Minnesota-Iowa, 1964, 44 cases; Iowa, 1966, 29 cases; and Missouri, 1969, 92 cases. All of these outbreaks originated from sausage prepared in non-inspected markets. The odds against a major outbreak are large, but as long as infected pigs continue to be marketed, the public health problem will continue to exist.

**Trichiniasis in Other Animals**

Contrary to common opinion, the trichiniasis problem is much more common in dogs and cats than in swine. A prevalence of 10.0% for dogs and 6.0% for cats was obtained in a VMRI study during 1954–57. The prevalence in dogs then declined to 2.0% in 1966–68 but is still 30 times the current rate for Iowa swine.

Wildlife are important reservoirs of the disease in Iowa. The parasite has been isolated from 15 species native to Iowa. A prevalence of over one percent was obtained for: fox, 6.4%; rat, 5.3%; mink, 5.0%; coyote, 4.3%; badger, 3.1%; striped skunk, 1.6%; and spotted skunk, 1.3%.

**Clinical Findings**

Trichiniasis has not been diagnosed for naturally infected animals. This should not imply the absence of clinical infections, nor correspondingly, a laxity in proper diagnosis on the part of the field veterinarian. Although a large majority of human and animal infections are subclinical, a comparison of trichina counts from clinically ill experimental swine at the VMRI with those obtained from natural infections indicates that morbidity and probably rarely mortality does occur. Trichiniasis is insidious. Because of somewhat limited herd involvement and the unspectacular and mimicking nature of the clinical syndrome, the disease is commonly overlooked.

The clinical picture is roughly related to the size of the infective dosage. Moderate to heavy infections in swine will produce a non-specific gastroenteritis accompanied by diarrhea as early as 3 days post-infection. During the muscle phase, beginning about 7 days postinfection, signs and symptoms are more prominent and include eosinophilia, anorexia—often accompanied by emaciation, muscle pain and swelling, dyspnea, occasional pyrexia, pale
or slightly injected mucous membranes, periorbital edema, malaise, and rough hair coat. Muscular involvement affects ability to rise and mobility. Weight retardation or loss in swine often occurs even in nonclinical infections, beginning 3 to 4 weeks after infection. Increased salivation is also common in dogs and cats. Most signs and symptoms recede 6 to 8 weeks after infection except in heavy infections.

**Diagnosis**

One of the primary deficiencies which has contributed to the lack of diagnosis in the living animal is the absence of effective diagnostic tools. Serologic tests which are efficacious for use on human sera are relatively ineffective for swine and untested for dogs and cats. Several of the recently developed tests, including variations of the fluorescent antibody procedure, show promise for swine but more experimental and field study is necessary before the tests can be safely utilized. Therefore, with the lack of diagnostic tests, diagnosis can only be made utilizing the previously discussed signs and symptoms. Although non-clinical infections in swine present a health hazard, they will continue to go undetected in the field until a reliable diagnostic test is developed.

Detection of the parasite in swine carcasses presents more reliable alternatives. Trichinoscopic examination of pieces of diaphragm compressed between glass plates has proved effective in Germany and many other countries. Although the safety has been questioned, the infective rate of one in 3,000,000 swine in Germany as compared to one in 800 in the U.S. demonstrates its efficacy. Cost, about 45 cents per animal, would be the primary factor prohibiting use of this procedure in the U.S.

The artificial digestion method, used in VMRI studies, is regarded as the most reliable method of detection. The procedure, as utilized in routine studies, uses a 50 to 100 gram sample of diaphragm. A modification of this procedure, the pooled sample method, was developed at the VMRI and is the basis of the proposed trichina elimination program developed by the USDA. The procedure costs less than 10 cents per animal and can readily be used in a highly mechanized slaughter house. Since the procedure uses a 5 to 8 gram sample of diaphragm, it is considered safer than the trichinoscopic method which uses a one gram or smaller sample.

**Transmission and Prophylaxis**

Trichiniasis should be the easiest swine disease to eliminate. Two cycles are perpetuated in nature: a synanthropic (domestic) cycle (centered on swine but including dogs and cats) and a natural (wildlife) cycle. The synanthropic cycle is of primary importance from public health and animal health standpoints. It is almost entirely dependent on man for existence, although occasional interchange with the natural cycle may occur. Infections in domestic animals are initiated principally through three media: commercial garbage, table scraps and other unofficial garbage, and wildlife carcasses. The latter two are of importance in Iowa since official garbage feeding has been banned. Fecal transmission and mechanical transmission by necrophagous insects have been demonstrated experimentally, but are generally considered minor under natural conditions.

Prevention of the disease can be accomplished by eliminating all potential sources of trichinae as food for swine. Unfortunately, educational programs for the swine producer and garbage cooking regulations have had only limited effectiveness. Thiabendazole has had therapeutic application for human trichiniasis and has proven effective prophylactically in experimental studies for swine. However usage of drugs for swine on a continuing basis seems impractical and undesirable.

**Future of the Problem**

The indication that the prevalence rate of the parasite in swine has reached a plateau or even a possible upswing, indicates that the parasite will continue to present a public health problem until a specific elimi-
ination program is initiated. The problem has proved costly, even though monetary values cannot be assessed. These include morbidity and mortality losses for both man and animals, human suffering, retardation of pork marketing potential, and cost of special processing methods needed to destroy trichinae in ready-to-eat products prepared under federal inspection.

Trichiniasis can be eliminated as a health hazard and now is the time to accomplish it. The prevalence rate is readily attackable. The USDA, with support of the pork industry and public health workers, has developed a workable program proposal. If the problem is again ignored, the disease will continue to blot the public health and veterinary record of the U.S.

Since trichiniasis is a zoonotic disease, the veterinary profession must lead the way in any elimination program. How can a veterinarian participate? First, most veterinarians in meat inspection or regulatory fields will automatically be drawn into any national elimination program which is developed. They will supervise laboratory inspection and traceback to the farm of origin of infected swine. They must determine the source of infection of swine and advise the farmer as to ways to eliminate the problem.

The practicing veterinarian also can contribute in several ways. First, he can caution swine producers and pet owners against the hazard of feeding raw garbage or wild animal carcasses to his animals. This would be the most effective means of eliminating the disease. Secondly, if the veterinarian encounters a disease of unknown etiology in swine, dogs, or cats, and if some of the diverse signs and symptoms of trichiniasis are evident, he should at least consider the possibility of this disease. Proper diagnosis would hasten control of the disease. Finally, the large animal veterinarian should caution his clients as to the danger of home-processed sausage and other pork products. Home or locally processed products are the primary vehicles for human outbreaks.

With full scale cooperation of veterinarians, the pork industry, and public health authorities trichiniasis can and will be eliminated as a health hazard in the U.S.

REFERENCES


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