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President's Message
Parasitic Diseases of Pork



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LAST YEAR IN THE MAY/JUNE ISSUE, *Sierra Sacramento Valley Medicine* published the story of Dr. Frederick Lloyd, a young pathologist who died in 1890 of military tuberculosis. An elegant and meticulously labeled slide set remained in his family for 118 years and contained the lung section from the autopsy Dr. Lloyd suspected had exposed him to the tuberculosis that killed him.

Dr. Lloyd's set contained not only slides of tuberculosis, but also human and animal slides of numerous other diseases. For this issue, I have selected two representations of parasitic diseases of pork not commonly seen today: *Trichinella spiralis* (the etiologic agent of trichinosis) and *Taenia solium* (the etiologic agent of cysticercus). The following is a slice of the 1890s medical milieu in which Dr. Lloyd practiced.

Trichinella spiralis

One of the smallest nematode worms of genus *Trichinella*, commonly *Trichinella spiralis*, causes trichinosis. The adult worm matures in the intestine of an intermediate host - usually a pig - and releases crops of larvae which bore through the intestinal wall to eventually encyst in muscle. Infection in humans results from ingestion of uncooked or undercooked meat containing encysted larvae. The larvae hatch after coming into contact with gastric digestive juices. The larvae mature and pass into the intestine to reproduce. Just one adult female can release up to 1,500 larvae which, in turn, bore through the intestinal wall and distribute throughout the body in skeletal muscle, forming cysts.

Dr. Lloyd's trichinosis slide is labeled "Feb 28 '89, Trichinae." Trichinosis had been discovered about 50 years earlier by an English first-year medical student, James Paget (who later described Paget's disease) after performing an autopsy on a man with a "sandy" diaphragm. Under microscopic examination, tiny cysts containing larva were observed. His proctor, Sir Richard Owen of the Royal College of Surgeons, named the parasite in a report to the zoological society of London. Owen did not credit Paget. Only Paget's later prominence, as well as an incidental letter written to a friend at the time, preserved his share of the discovery.

Joseph Leidy in Philadelphia in 1846 noticed specks in a slice of pork that he was eating and recalled seeing similar specks in dissected human muscle earlier. Under the microscope, Leidy confirmed the presence of encysted *Trichinella* larvae that had earlier been described in Owen's article. Making the connection between the *Trichinella* and consumption of undercooked pork, Leidy reported his findings

in the *Proceedings of the Academy of Sciences of Philadelphia* in October 1846 and urged thorough cooking to kill the trichinosis parasite.

Leidy's work apparently was either ignored or not known to European scientists. Dr. Rudolph Virchow, the famous German pathologist, in the 1850s demonstrated that trichinosis was spread animal-to-animal through ingestion of infected meat. It was not until 1860 that trichinosis was found to cause significant human morbidity and mortality. Another German physician, Frederich von Zenker, documented the trichinosis infection of a young servant who died after eating contaminated, raw pork sausage.

In 1900, an estimated one in six Americans was infected with *Trichinella spiralis*. Since then, public education concerning proper cooking of pork as well as laws restricting pork contamination have been effective. According to the CDC, trichinosis cases dropped dramatically to 500 in 1948 and to 74 in the period 1997-2001.

In the developing world trichinosis is more frequent. During the Thai New Year, 200-600 cases occur annually after consumption of a delicacy, "larb," which incorporates uncooked pork. China has the highest case reports with human prevalence rates between 0.66 and 12 percent. Prevalence rates in pigs are as high as 50 percent in some provinces.

Trichinosis is difficult to treat, and, once encysted in skeletal muscle, treatment is essentially symptomatic. To kill *Trichinella* larvae, the USDA recommends freezing pork at 5°F for 20 days or heating to a uniform internal temperature of 144°F. Smoking or salting may not kill the encysted larvae.

Taenia solium

Taenia solium is the pork tapeworm, a cestode in the family *Taeniidae*. *Taenia solium* has four suckers on its scolex as well as two rows of hooks. Humans and pigs can be infected, but humans are the definitive hosts for this tapeworm. Systemic infection of humans is caused by eating eggs shed in the feces of a human tapeworm carrier. Once eggs are ingested, oncospheres hatch in the intestine, invade the intestinal wall, and migrate to skeletal muscle as well as brain and other organs of the body.

The most serious manifestation of disease is neurocysticercosis in which fluid-filled bladders containing an invaginated scolex develop in the brain. Most cysticerci are 0.5 cm to 1.5 cm in diameter but, in brain, may be as long as 20 cm and contain 60 ml of fluid. Humans become tapeworm carriers after eating undercooked pork containing cysticerci. The ingested cysticerci develop into adult tapeworms in the small intestine. Adult tapeworms develop up to seven meters in length with up to 1000 proglottids each containing up to 50,000 eggs. These may live in the intestine for years.

Tapeworms have been recognized as human pathogens since antiquity but it was not until the 1850s that the lifecycle of *Taenia solium* was developed. Dr. Frederich Kuchenmeister, a German gynecologist, established the link between cysticerci and adult tapeworms in a study of prisoners sentenced to death. The prisoners were fed cysticerci from infected pork.

Following their executions, Kuchenmeister opened their intestines to find developing and adult tapeworms. With this experiment, he dismissed a prevailing view that cysticerci were degenerate bodies. Kuchenmeister offended ethical sensibilities and was criticized.

Taenia solium is found worldwide. The precaution of cooking pork before consumption for *Trichinella spiralis* reduced the incidence of *Taenia solium*. In the United States, immigrants from Mexico, Central and South America and Southeast Asia account for most of the domestic cases of cysticercosis.

It is remarkable that Dr. Lloyd's slides can still be interpreted over 100 years after preparation. The yellow borax-carmin stain is now little used. Modern slide stains/counterstains are much easier to read but who knows what they would look like 100 years from now?

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