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Lymphocytic Choriomeningitis Virus (LCMV) - A possible health concern for workers associated with stored food

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Abstract

Lymphocytic choriomeningitis, or LCM, is a rodent-borne viral infectious disease that causes meningitis, encephalitis, or meningoencephalitis. Its causative agent is the lymphocytic choriomeningitis virus (LCMV), a member of the family Arenaviridae. The primary host is the house mouse, *Mus musculus*. Infection in house mouse populations may vary by geographic location but, about 5 % of mice throughout the United States carry LCMV. The virus is found in the saliva, urine, and feces of infected mice. To date, thousands of studies have been done to examine the impact molds and pesticides have had on the indoor air quality relative to structures human inhabitants, however, no studies have been conducted to determine the potential for mouse fecal pellets containing LCMV to negatively impact indoor air quality. This paper reviews the relationship between LCMV and rodent populations that infest food storage, processing and service facilities, summarizes the research completed to date on the presence of LCMV in urban structures, and the relevance to pest managers and employees of food production facilities.

Key words: Lymphocytic choriomeningitis virus, house mouse, *Mus musculus*, rodents, disease transmission

Introduction

The house mouse (*Mus musculus*) is the most common urban rodent pest worldwide (Corrigan, 2004). In fact, in the oldest and largest cities the mouse is ranked consistently among the top three most important pests. The house mouse is the number one mammal that humans actually share their dwellings with—albeit unwillingly and in many cases unknowingly. This includes our farms, grain storage facilities, food processing facilities, restaurants, and virtually most other structures of all types. Few structures are immune to having a mouse (or many mice) invade the structure sometime during the course of the building's lifetime (Corrigan, 1999; 2004).

But despite this fact, it is somewhat incredible to note that very little “real-world research” has been conducted on the health significance of the mouse relative to possible transmission of microbial pathogens (excluding the significance of mouse urinary protein and allergens) in mouse urine and feces. Mouse excrement is deposited within many of our everyday buildings in copious amounts. It is common to find hundreds, and sometimes thousands of rodent fecal pellets (often called “droppings” by the lay public) in a facility. Fecal pellets are also deposited by mice in virtually any area the mice travel or nest such as building wall voids, crawlspaces, basements, I-beams, equipment voids and beneath false

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floors of grain bins.

In most cases, residual mouse excrement that is not in plain sight is “ ignored” or perhaps simply not considered by either building occupants or by the pest control industry performing rodent control programs to be of any health significance. However, some cursory research over the years warrants that residual excrement should be profiled relative to general health risks for both building occupants such as employees and customers and pest management professionals performing routine mouse control.

For example, the disease lymphocytic choriomeningitis (LCM) is a rodent-borne viral infectious disease that is associated with feces from the common house mouse (Peters et al., 1991; Peters and Ksiazek, 1995). Early research on this virus suggests that lymphocytic choriomeningitis virus (LCMV) can be found in up to 50% of house mouse populations. According to the United States Centers for Disease Control (CDC), LCMV may be contracted by humans through the inhalation of dust contaminated with dried mouse feces or through consumption of food adulterated with mouse excrement.

It is especially important to note that the CDC also reports that LCMV in urban areas is grossly unrecognized and under-reported because it mimics symptoms of the “flu”(CDC, 2005). In April 2005 LCMV made the news headlines when four persons in the United States who received organ transplants from a common donor developed similar complications following transplant surgery. All four patients tested positive for LCMV and three died due to complications. Although the donor’s death was not related to LCMV, the donor was probably infected with LCMV from a pet hamster bought three weeks prior to the donor’s death.

The house mouse problem

The house mouse is the most common rodent pest encountered by pest professionals. House mice are ubiquitous and have been described by

prominent mammalogists as a “weed” species (Corrigan, 2004). House mice produce 50-75 fecal pellets daily and purge thousands of micro-droplets of urine each day. In turn, mice contaminate most of the objects they encounter during their routine foraging activity (Meehan, 1984).

House mice live secretively in and around urban structures and often go undetected until the client observes rodent fecal pellets. In turn, clients contact a pest management company wanting to “get rid of” the offending mice. The pest management firm goes to the client’s home or facility, eliminates the mouse or mice and charges the client for the service. But the biological residues (fecal pellets, urine, saliva and dander) are, in the majority of cases, left behind.

In the United States alone, hundreds of thousands —and possibly millions— of rodent fecal pellets can be found in structures. More than likely every food storage, food production and food-serving establishment contains rodent excrement in some quantity or another. For the most part, pest management professionals are ignoring them or are not reporting the extent of rodent excrement within these structures and the building occupants are for the most part totally unaware of both the fact that the excrement is present, or if they are aware, they assume the excrement is of little or no consequence.

Lymphocytic choriomeningitis

Lymphocytic choriomeningitis (LCM), is a rodent-borne, viral infectious disease that causes meningitis (inflammation of the membrane that surrounds the brain and spinal cord), encephalitis (inflammation of the brain), or meningoencephalitis (inflammation of both the brain and meninges). Its causative agent is the lymphocytic choriomeningitis virus (LCMV), a member of the family Arenaviridae, that was initially isolated in 1933 (Ryan, 1997).

It is important to note that rodent-borne Arenaviruses were responsible for the death of seven people in California in 2001 (Reuters,

2001). Although LCMV is most commonly recognized as causing neurological disease, as its name implies, asymptomatic infection or mild febrile illnesses are common clinical manifestations. Additionally, pregnancy-related infection has been associated with abortion, congenital hydrocephalus and chorioretinitis and mental retardation.

LCM and milder LCMV infections have been reported in Europe, the Americas, Australia, and Japan, and may occur wherever infected rodent hosts of the virus are found. However, the disease has historically been underreported, often making it difficult to determine incidence rates or estimates of prevalence by geographic region. Some early serologic studies conducted in urban areas have shown that the prevalence of LCMV infection among humans is estimated to range from 2 % to 10 % (Armstrong, 1940; Gregg, 1975).

The role of the house mouse and LCMV transmission

LCMV is naturally spread by the common house mouse. Mice can become chronically infected by maintaining virus in their blood and/or persistently shedding virus in their urine, a common characteristic of other Arenavirus infections in rodents (Jahrling and Peters, 1992; Peters, 1996; 1997). Chronically infected female mice usually transmit infection to their offspring, which in turn become chronically infected.

Humans become infected by inhaling infectious aerosolized particles of dried rodent urine, feces, or saliva, or by ingesting food contaminated with virus, by contamination of mucus membranes with infected body fluids, or by directly exposing cuts or other open wounds to virus-infected blood (Smithard and Macrae, 1951) person-to-person transmission has not been reported, with the exception of vertical transmission from an infected pregnant woman to fetus.

Symptoms of LCM and persons at risk

Persons infected with the LCMV typically exhibit fever, malaise, anorexia, muscle aches, headache, nausea, and vomiting. Occasionally, sore throat, cough, joint pain, chest pain, testicular pain, and parotid (salivary gland) pain accompany the initial phases of infection. After a few days, the infection enters a remission, but is then followed by a second phase, consisting of symptoms of meningitis (e.g. fever, headache, and a stiff neck) or characteristics of encephalitis (e.g. drowsiness, confusion, sensory disturbances, and/or motor abnormalities, such as paralysis).

According to the CDC, individuals of all ages who come into contact with urine, feces, saliva, or blood of the house mouse are potentially at risk for infection. Human fetuses are at risk of acquiring infection vertically from infected maternal blood. Thus, persons inhabiting buildings where mouse infestations are chronic or severe may be particularly susceptible to LCMV. Additionally, pest management professionals working in such areas may be at a higher risk than the general public.

LCMV prevention and pest management industry's role

Like many other rodent-borne infectious diseases, avoiding or minimizing direct physical contact with rodents or exposure to their excreta can prevent LCMV infection. Adequate ventilation should be provided to any heavily infested, previously unventilated enclosed room or dwelling prior to cleanup. The CDC (2005) presents the following message to the general public and to the pest management industry: "The geographic distributions of the rodent hosts of LCMV are widespread both domestically and abroad. However, infrequent recognition and diagnosis, and therefore underreporting of LCM, have limited scientists' ability to estimate incidence rates and prevalence of disease among humans."

Understanding the epidemiology of LCM and LCMV infections will help to further delineate risk factors for infection and develop effective preventive strategies. Increasing physician awareness will improve disease recognition and reporting, which may lead to better characterization of the natural history and the underlying immunopathological mechanisms of disease, and stimulate future therapeutic research and development.

Current research is looking at the prevalence of infected rodent droppings in urban structures to determine the risk to pest management professionals and employees that work in structures infested with house mice. We have developed a laboratory assay to detect the RNA of the virus in rodent droppings and are currently screening droppings from various structures throughout the United States.

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