Original Contributions

Lymphocytic Choriomeningitis Outbreak Associated With Pet Hamsters

Fifty-Seven Cases From New York State

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• An outbreak of lymphocytic choriomeningitis (LCM) associated with pet hamsters acquired through a nationwide distributor was recognized in New York in February 1974. In upstate New York, 57 cases occurred in a four-month period. Complete information was obtained on 49 patients ranging in age from 3 to 70 years. Characteristic findings included fever (90%), headache (85%), and severe myalgia (80%). Typically, laboratory findings consisted of a normal blood cell count and cerebrospinal fluid with mononuclear leukocyte pleocytosis and moderate hypoglycorrhachia.

All patients had contact with hamsters from one distributor. Most of the hamsters were acquired in mid to late December 1973, but some as late as March 1974. From each of eight families in which hamsters were available, at least one hamster had detectable complement-fixing antibodies for LCM. Infection rates within families varied with location and type of hamster cage; open cages and cages situated in common living areas were associated with highest infection rates (45% and 52%, respectively). Severity of illness was not associated with direct contact with hamsters. Onset of illness occurred between 8 and 90 days after initial exposure to hamsters.

(*JAMA* 232:494-500, 1975)

WITH one exception, previously reported outbreaks of human lymphocytic choriomeningitis (LCM) associated with hamsters have occurred in a laboratory setting.[1-3] In 1972, Ackerman et al[4] compiled 47 cases of LCM associated with pet hamsters, which had occurred in Germany during a two-year period.

See also p 501.

In late January 1974, a 24-year-old woman was hospitalized in Rochester, NY, with encephalomyelomeningitis. Four members of her family had a milder illness, including a 16-year-old brother with orchitis. The family had purchased a pet hamster just before Christmas. Two members of an unrelated family contracted LCM-like illness following purchase of a pet hamster from a different store in late December. Lymphocytic choriomeningitis was serologically confirmed in the patients in both families by rising titers of complement-fixing (CF) antibodies. Within a week, serologic screening of patients with aseptic meningitis identified a third case in Albany, NY, again associated with a recently acquired pet hamster. Although these families purchased hamsters from different stores, all three stores were supplied by the same interstate distributor.

This report records clinical and epidemiologic aspects of 57 New York cases of LCM infection and pet hamsters. The patients have come from widely separated areas with independent hamster distribution routes that have in common only the starting point, a Florida supply house.

METHODS

Confirmation of LCM was based on the detection of either complement-fixing (CF) antibodies of 1:4 or more, or indirect fluorescent (IF) antibodies of 1:8 or more, as done by the Virology Division of the New York State Health Department.[5-7]

Serologic screening was done in patients clinically suspected of having

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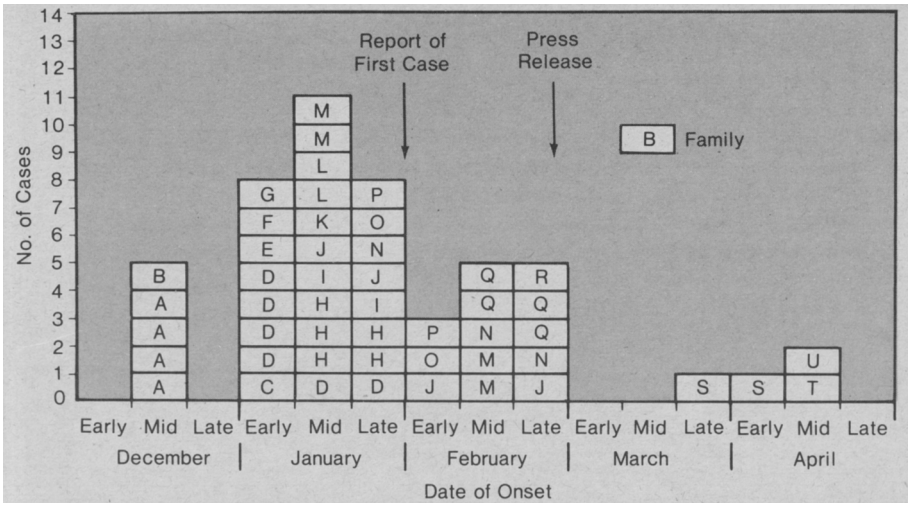

Fig 1.—Lymphocytic choriomeningitis illness among New York State residents, 1973 to 1974 (early indicates first to tenth days of the month; mid, 11th to 21st days; late, 21st day to end of the month).

Table 1.—Symptoms of 49 Persons With Positive Titers for Lymphocytic Choriomeningitis

	No. of Cases	Percent
None recognized	3	6
Fever	44	90
Headache	42	85
Myalgia	39	80
Pain on moving eyes	29	59
Nausea	26	53
Vomiting	17	35
Biphasic illness	12	24
Sore throat	12	24
Photophobia	12	24
Cough	9	18
Swollen glands	8	16
Diarrhea	8	16
Rash	6	12
Upper respiratory tract symptoms	6	12
Orchitis	1	5*

*Of males only.

LCM and in those considered to be at high risk of contracting the disease because of (1) living in the house with a hamster or a person found to be serologically positive, or (2) working in the distribution or sale of hamsters from the implicated supplier. Thirty-five persons working with or near hamsters from other suppliers were also tested. Hamsters were submitted from Rochester area homes at the request of the health department through publicity naming the supplier and the period of risk as then defined (from mid-December 1973 to mid-January 1974). Hamsters were also tested, when available, from the homes of known LCM patients. Twenty-seven hamsters were obtained in early February directly from local retailers who used the implicated supplier.

In the Rochester area, blood was drawn from these hamsters by intracardiac puncture and the serum sent with frozen carcasses to the New York State Health Department for CF and plaque-neutralizing antibody testing. Viral isolation was attempted by mouse inoculation[8] and endotoxin challenge[9] on more than 100 hamster carcasses.

Patients or family members were interviewed for specific information about the illness and possible hamster contact. Illness data included date of onset, symptoms, duration, medical attention, and outcome. Hamster data included source, date of purchase, amount of contact, cage type and location, and duration of contact. Physicians were interviewed for initial impression, physical findings, clinical course, and laboratory results. Notification of suspected association between LCM and pet hamsters was sent to all local physicians and veterinarians through newsletters and through their respective societies. A press release to the geneal public from both local and the state health departments was made on Feb 28 followed by a nationwide report in the *Morbidity and Mortality Weekly Report*.[10]

RESULTS

Clinical Data

Fifty-seven persons had confirmed LCM; clinical data are available for 49 of these. Cases occurred from December 1973 to mid-April 1974, peaking in January and tending to cluster by families (Fig 1). Illnesses in handlers (indicated as F, G, and K in Fig 1), exposed over long periods to hamsters from the implicated supplier, all occurred in January. Patients ranged in age from 3 to 70 years with a mean age of 24.2 years and a median age of 23 years. Twenty-three were male and 28 were female. Twenty-nine patients (59%) consulted a physician and 11 were hospitalized.

Three seropositive persons denied having been ill, including a 4-year-old boy whose parents were ill, a 63-year-old woman employee who handled hamsters once every other week, and a 70-year-old man who lived with an ill family member.

Predominant symptoms included fever, headache, and myalgia (Table 1). Fever varied between 37 and 41 C (100 and 106 F), but was rarely above 39 C (102 F) and was often quite intermittent. Myalgia, frequently described as severe, occurred especially with eye movements, but also involved larger muscle groups including neck, shoulder, back, and legs. Photophobia occurred less commonly. A wide variety of nonspecific symptoms occurred in 10% to 50% of cases; nausea and vomiting were most common.

Skin eruptions varied. Two patients, aged 3 and 6 years, had an erythematous eruption on the face and trunk lasting three to five days. Mild desquamation followed in one patient.

Three illness patterns, all in young women, aged 14, 18, and 19 years, resembled mononucleosis, with prolonged intermittent fever for two to four weeks, adenopathy, pharyngitis, extreme fatigue, and rash. The eruption was blotchy, red, and slightly raised, occurring about the face and upper trunk and disappearing within 24 to 36 hours of onset. All three pa-

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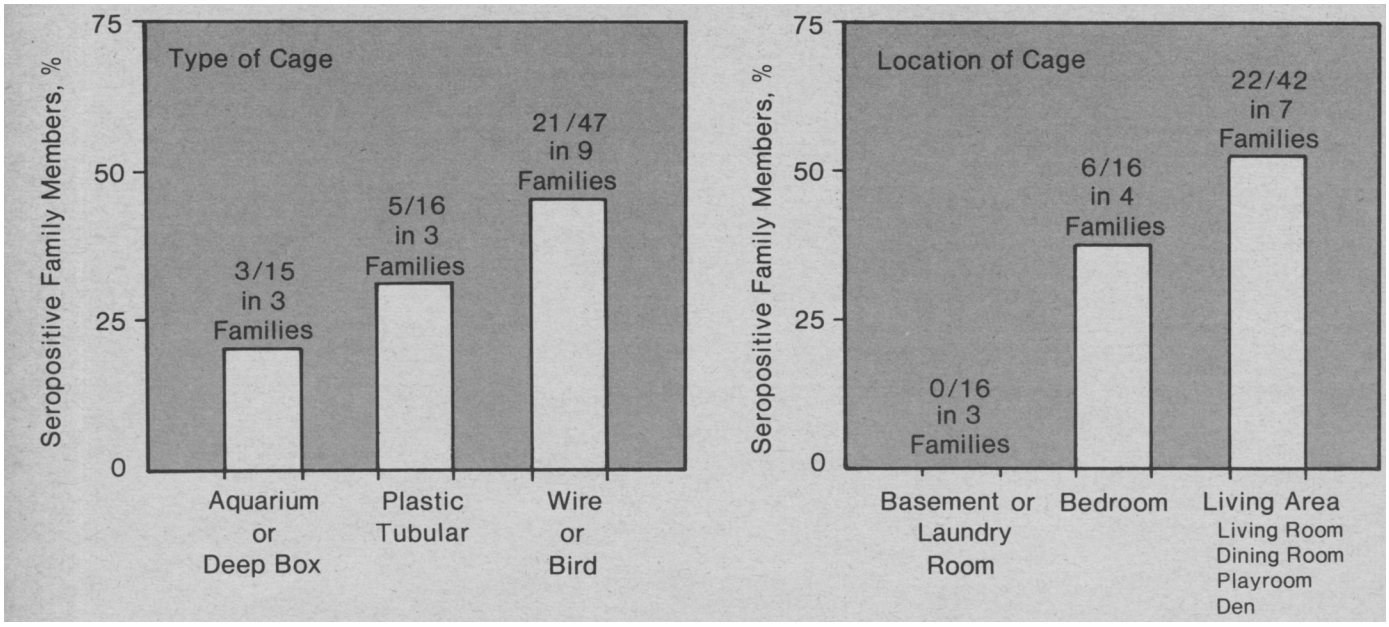

Fig 2.—Lymphocytic choriomeningitis in family members, by type and location of hamster's cage.

Table 2.—Risk* to Persons Working With Hamsters

	Contact With Hamsters					
	Never	<Once Weekly	≥Once Weekly	Daily	No Information	Total (%)†
Direct contact with hamsters from implicated supplier	1/6	1/10	1/10	1/10	0/12	4/48(8)
Direct contact with hamsters from other suppliers	0/3	0/7	0/2	0/23	0/0	0/35

*No. of seropositive persons/total tested.
†P=.12 (by Fisher exact test).

tients had negative heterophil tests.

The sixth case of rash occurred in a 34-year-old woman who gave a striking history. On the day of recovery from three days of fever and myalgia with eye pain, she noted a pruritic rash and painful swelling of her finger at the point at which a hamster had bitten her two weeks before. The initial wound had broken the skin, but that had long since healed. The rash consisted of discrete, tiny clear-fluid vesicles on a 3-mm erythematous base occurring on her back (about 24) and chest (about 12). The finger swelling and rash both disappeared within 48 hours. Four days later, however, stiffness of her right knee developed that progressed over the next week to frank arthritis with warmth, swelling, or pain of incapacitating severity involving both hips, knees, wrists, and fingers. This was initially interpreted as a reaction to tetracycline given for the presumed infected hamster bite, but the arthritis progressed even after the antibiotic therapy was discontinued. A five-day course of corticosteroids was initiated eight days after the onset of the arthritis, and within two days the arthritis completely resolved except for a slight residual stiffness in one wrist, which persisted for two months.

The symptoms of encephalitis and encephalomyelitis included disorientation for two to three days in one case, delirium for five days followed by a total amnesia for the illness in another patient (whose illness was initially diagnosed as psychosis), and ataxia, dysphasia, and atonic bladder in a third case (the index case). All these patients fully recovered.

A 38-year-old woman who became ill in early April had a spontaneous abortion following infection. She was in her first trimester of pregnancy with a positive pregnancy test on April 8. On May 8, the woman spontaneously miscarried an abortus described as being "the size of a half dollar." The abortus was not saved for examination.

The duration of illness varied from one day to two months. Most "flu-like" illnesses lasted between 5 and 15 days. Twenty-five percent of patients had a biphasic pattern of myalgia and fever and typically were ill three to seven days, well three to five days, and ill another three to five days. The second phase of the illness was commonly less severe, although with similar findings. Preceding or concurrent upper respiratory tract symptoms were unusual.

The initial impression of physicians after examination was usually nonspecific. "Flu," "viral illness," or "possible mononucleosis" was the diagnosis for the illnesses in 18 persons, aseptic meningitis for seven, encephalitis for two, and psychogenic illness for two. In one case, the initial diagnosis of psychosis was soon changed to probable tuberculosis meningitis, for which therapy was initiated and hospitalization with isolation continued for more than a month. This woman had a history of active tu-

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berculosis treated for two years in the mid-1950s.

Fourteen persons had complete blood cell counts done, all of which were normal, including differential cell counts. Platelets mentioned or counted for eight patients were adequate in number.

Lumbar punctures were known to have been done on 13 patients. For a patient from a rural area, the results were questionable for technical reasons. The other 12 patients had pleocytosis with cell counts ranging from 151 to 1,500 cells (ten of 12 had < 700 cells), more than 90% of which were mononuclear leukocytes. Protein values varied from 30 to 180 mg/100 ml (ten of 12 had > 50 mg/100 ml). Glucose values ranged from 24 to 72 mg/100 ml (seven of 12 had < 45 mg/100 ml), but serum glucose determinations either were not done, or done at varying time intervals before or after lumbar puncture, prohibiting consistent interpretation. Many patients had symptoms or signs compatible with central nervous system involvement, but were not examined for meningitis.

Antibody levels ranged from CF titers of 1:4 to 1:32, and IF titers from 1:8 to 1:256. These titers did not correlate with severity of illness, but were performed at many different stages of illness. All persons with CF antibodies were positive for IF antibodies with two exceptions, a 63-year-old-woman and a 70-year-old man, neither with any history of illness. Three persons had IF antibodies, but no CF antibodies to LCM. In each there was a clear recent association with a hamster from the implicated company and a history of compatible illness.

Epidemiologic Data

The association of cases of known LCM illness with pet hamsters has been striking. Forty-nine patients from 21 households about which information is available had known contact with hamsters from the implicated supplier. In four households the contact took place solely at work. Hamsters were available for testing in eight of the other 17 households, and at least one hamster was seropositive for CF antibodies in each family.

The amount of contact varied from intimate handling to living or working in close proximity to the ham-

Fig 3.—Cases of LCM by period between contact with last hamster introduced into household and onset of illness.

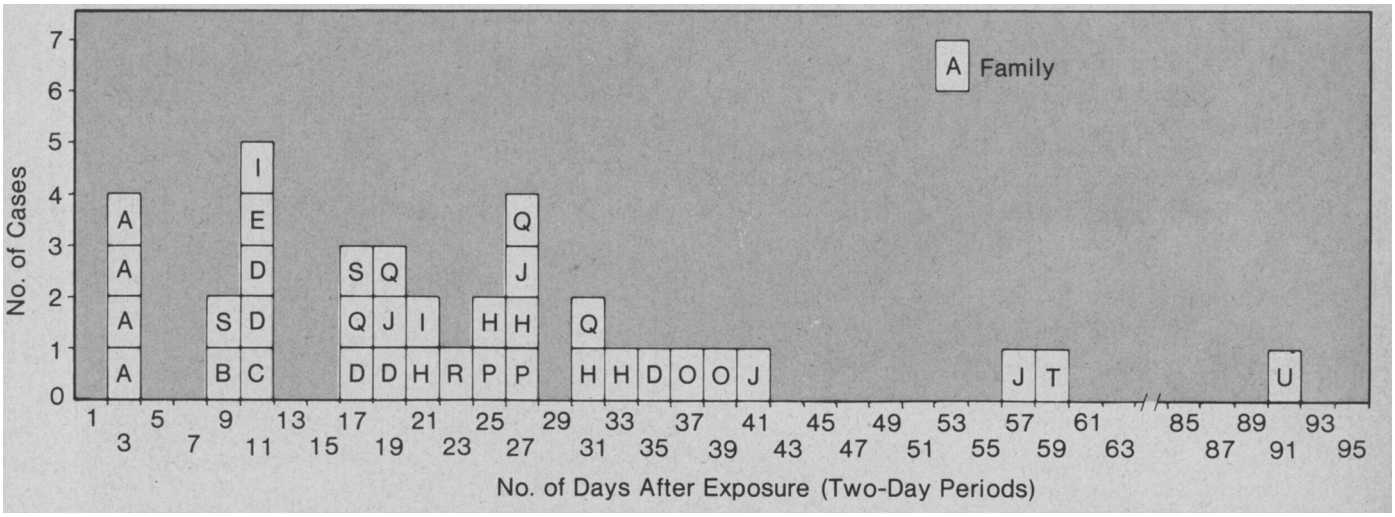
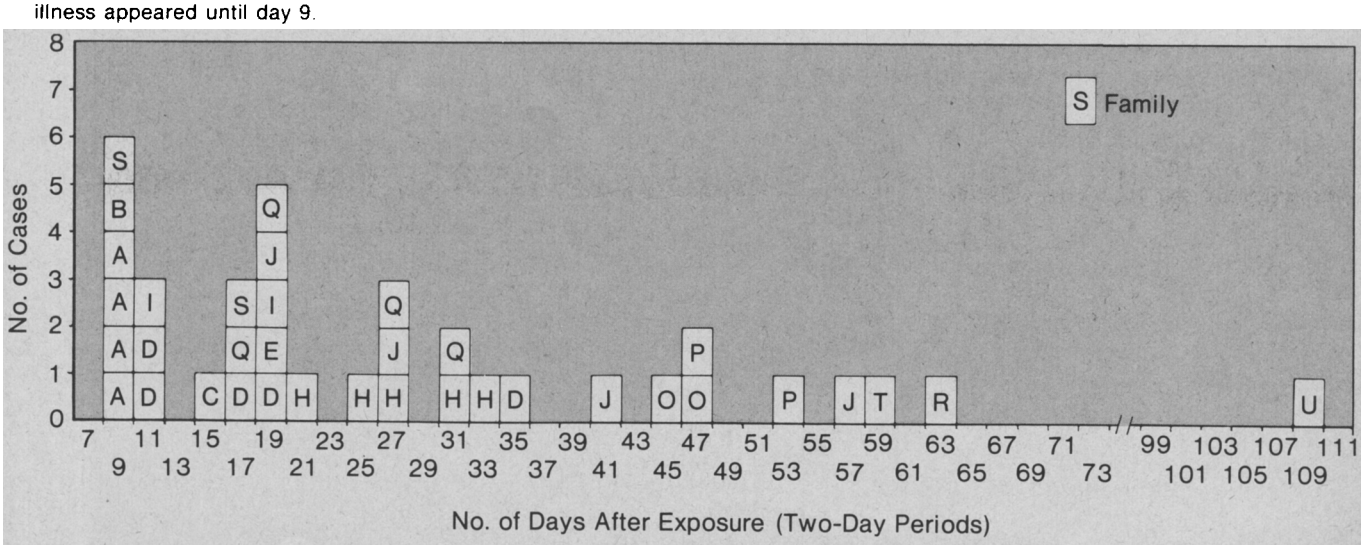


Fig 4.—Cases of LCM by period between initial contact with first hamster introduced into household and onset of illness. Note that no illness appeared until day 9.



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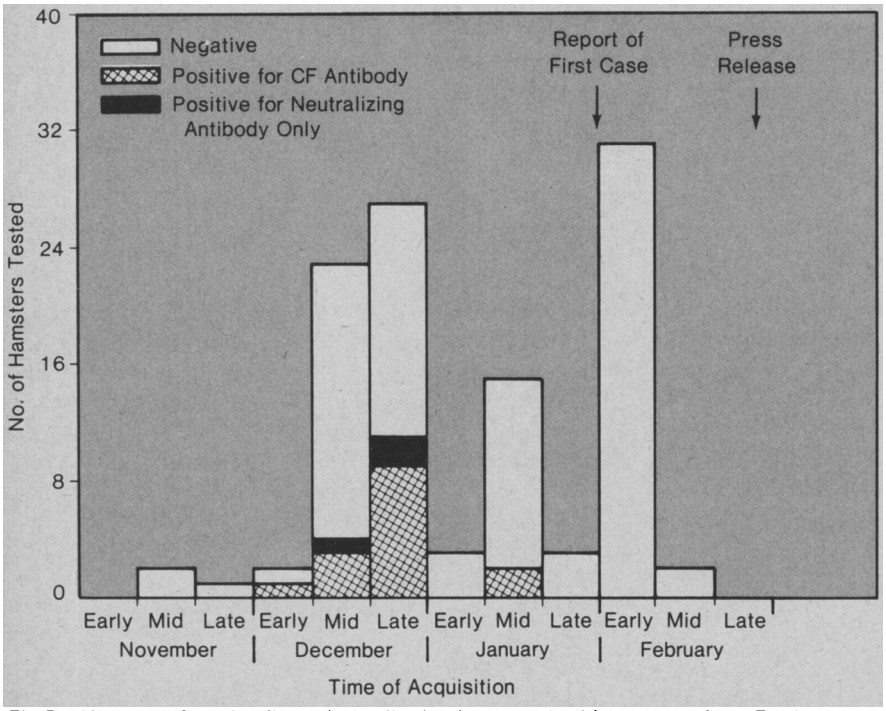

Fig 5.—Hamsters from implicated supplier by date acquired from store (from Rochester, NY, area only).

sters, but without direct contact. Severity of illness did not correlate with degree of contact. The person with the most serious symptoms, those of encephalomyelomeningitis, denied having had any direct contact with hamsters, although hamsters were kept in the dining room of her home.

Within households with a confirmed human or hamster case, 15 families had at least 75% of family members tested serologically. Six with 30 members had no cases, but six others with 34 members had at least 50% of members seropositive. Three families had intermediate infection rates. A number of factors were assessed to determine this difference in infection rates within these households.

Seropositive hamsters acquired by families with no human illness were identical in origin and date of acquisition and in general size and description to the hamsters acquired by the families with high infection rates. Only for two hamsters could the virus be recovered on culture. Both were from the same family, and no human cases were identified in the three people in that home.

A difference did appear to occur in infection rate that correlated with the cage type and location of hamsters in the household. Wire cages were associated with the highest infection rates, 21 of 41 persons (47%) from six of nine families, as opposed to aquariums or deep wooden boxes with poor ventilation, which had the lowest infection rate, three of 15 persons (20%) from two of three families. Plastic tubular type cages, which are fairly well ventilated, were associated with intermediate infection rates, five of 16 persons (31%) from one of three families.

Having the cage in a common living area was related to an even higher infection rate, 22 of 42 persons (52%) from seven of eight families. A location outside the usual family living area such as a basement or laundry room was correlated with no infections in the 16 persons from three families. Bedrooms as locations for cages gave an intermediate rate of infection: six of 16 persons (38%) from two of four families were seropositive (Fig 2).

Data correlating cage type and location of cage with infection rates are supported by the data from a serologic survey of distributors and persons working with hamsters in department stores. The stores that received stock from the implicated supplier were largely chain stores in which pet supplies were only one small aspect of their business. These stores virtually all used aquarium-style tanks or glass-fronted cages with poor ventilation to contain the hamsters. Of 48 persons tested, only four were seropositive (8%). The amount of contact that these persons had with hamsters varied from none to daily, but all worked in the area of the hamsters (Table 2). The one person who denied contact was a janitor who swept around the cages daily. In all three persons in whom clinical illness could be recognized, each had his illness in early to mid-January. The fourth denied illness.

The persistence of infectivity of hamsters was difficult to determine. Unfortunately, most families obtaining hamsters had, in addition to many children, many hamsters. Often hamsters died or were lost and new hamsters acquired. Looking, therefore, at the last exposure to a new hamster for the last possible source of exposure into the family (Fig 3), there is an obvious tendency for cases to cluster about a common family grouping suggesting a common point of exposure that involved the family group. However, several families do not fit this pattern; one family had the onset of illness spread out over 25 days (family D), and the other over 40 days (family J).

Further evidence of the continuing risk are the illnesses in two families that began in mid-April. The last exposure to a new hamster occurred 58 days before the illness in one case (in family T) and 90 days in the other family (family U). In both families, compatible illness occurred in at least one other family member at approximately the same time, suggesting clustering, but no other members were screened for antibodies to LCM.

An attempt was made to determine the incubation period by comparing the date of onset of illness with the first exposure to a new hamster (Fig 4). No illness occurred in less than 8 days, and 8 to 12 days appear to be a common period.

No cases are known in which the hamster was acquired later than March 16. Seventy-five percent of

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families had acquired their hamster between mid-December and mid-January. Of those hamsters voluntarily submitted for sacrifice by Rochester area persons, the earliest date of acquisition of a seropositive hamster was Dec 10 and the latest, Jan 16. Forty-one percent of hamsters acquired in the late-December period were positive for CF or neutralizing antibody (Fig 5).

Data were acquired about the risk of exposure to hamsters that were serologically negative. Eighteen members of four families ranging in age from 4 to 44 years were serotested for LCM antibodies on the basis of living with a hamster initially found to be serologically anticomplementary, but later proved by neutralization tests to be negative. None of these persons had evidence of LCM antibody.

In an attempt to determine wheth- the hamsters sold by suppliers other than the implicated company might also be infected, 35 store employees with varying degrees of association with hamsters from other suppliers were bled for LCM antibodies in late February. None of these employees was positive (Table 2). In addition, no cases of LCM were associated with hamsters from any but the implicated company.

COMMENT

Lymphocytic choriomeningitis has a wide spectrum of manifestations, and rise in antibody titer is the most conclusive means of identifying cases, other than by virus isolation. Because of problems in obtaining serial titers, we identified a case by the presence of CF or IF antibodies, recognizing the possibility of including earlier infections, especially those with IF antibodies, which may persist for two years or more.[7] Those three of 57 cases (5%) with only IF antibodies were similar, in initial signs and symptoms and hamster exposure factors, to patients with both IF and CF antibodies.

The distribution of symptoms in patients is similar to that recently reviewed by Lehmann-Grube[11]; some patients were asymptomatic and some were severely affected with encephalomyelomeningitis. Fatalities have been reported by Smadel et al[12] and others, but are rare. None were recognized here. Rash is not a common manifestation and has not been well described. Both orchitis and frank arthritis, each seen once in the current outbreak, are similar to that reported by Baum et al.[2] Paralytic symptoms, seen in the first case identified (atonic bladder), have been discussed by Maccallum and Findlay[13] and are unusual.

The disease cannot be dismissed as minor "flu" illness; it was described by many patients as the worst illness of their lives, and several were hospitalized for prolonged periods. Physicians were generally unaware of the manifestations, and it was perhaps due to the clinical judgment of one physician (Michael Brandriss, MD, of the University of Rochester School of Medicine) that this outbreak was recognized at all. The majority of patients were well by the time of the identification of the index family.

Clinical clues to the diagnosis were the severity of the myalgia and the associated aseptic meningitis, with a moderately low level of cerebrospinal fluid glucose. A few other diagnoses have this characteristic combination, although certainly not all cases will be so classic. A third epidemiologic marker was illness in family members when the source of infection was in the home.

The exposure of young families to hamsters bearing LCM raises the question of risk to pregnant women. The possible danger to the fetus was pointed out initially by Komrower et al,[14] and similar cases with hydrocephalus and chorioretinitis have been reported in the recent German outbreak.[15] The woman who spontaneously aborted after a possible LCM infection in the first trimester may represent part of the picture of transplacental illness.

The association of LCM with hamsters has been reported among laboratory workers on several occasions. However, the opportunity to evaluate risk factors in the home setting where exposure is limited to a discrete number of animals is new, with only one precedent in Germany.[4] It appears that the type and location of the cage is the most important factor in the transmission of this disease from hamsters to humans within the home and that direct physical intimacy is not important. These findings contribute to the concept of an infection spread by an airborne or droplet route, as has been shown to be possible in mice and guinea pigs.[16]

Mice bearing disease may be clinically well or develop lethal clinical illness characterized by seizures, wasting, and rapid death. Variability of the symptoms has been recently reviewed by Hotchin[17] and may relate to the stage in life when the infection occurs. Mice appear able to excrete the virus for long periods of time when infected as neonates or during the intrauterine life. Yet those mice infected as adults almost never spread the disease, whether asymptomatic or symptomatically ill.[18]

The information about hamster infections has come mainly from work with adult hamsters in which the circulating viruses are cleared within four weeks of infection.[19] However, in hamsters infected early in life, the virus may be recovered for up to three months.[20] Since hamsters for sale in stores are young, most often weanlings, infected hamsters may be expected to be most contagious soon after acquisition.

There are several explanations for the late onset of human illness. Continued shedding of the virus by the hamster is a possibility. However, culturing for LCM virus by the New York State Health Department has been done in more than 100 hamsters and has been unrewarding. A second possibility, the persistence of a viable virus in the environment, is unlikely in view of the great lability of the virus in the laboratory setting.[11]

A third possibility, biological variability in the incubation periods, seems an unlikely explanation, as the majority of cases appear to cluster by family. Finally, LCM illness resembles flu-like conditions resulting from many causes, and it is possible that patients had clinically unrecognized illness causing seroconversion earlier, but their illnesses were detected on screening for an unrelated illness. One of the patients with a late onset, however, had proven aseptic meningitis in addition to an illness clinically compatible with LCM, which makes the possibility of an erroneous clinical

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diagnosis less likely for this illness.

There was apparently a large influx of infected hamsters during the Christmas season, as reflected in the epidemic curve of human cases and in the percentage of hamsters found to be seropositive in late December. The percentage of hamsters infected during this period is no doubt exaggerated, since submitting hamsters for testing, a lethal experience for the animal, was voluntary, and persons doing so would be more likely to have had an illness about which they were suspicious or curious.

The implicated supplier is the leading source of hamsters for retailers, selling approximately 1 million a year. This company distributes nationally, as reflected by the widespread reporting of cases associated with this outbreak.

In the Rochester area, 19 cases were identified. The distributor estimated that 500 hamsters were sold in this area during the period of high infectivity between late December and late January. If this conservative ratio were to be accepted as representative for the 100,000 hamsters sold nationwide during the same period, nearly 4,000 cases can be estimated to have occurred. It is possible that the number of infected hamsters entering Rochester was unusually high. However, a neighboring city on the same distribution route received about 800 hamsters during this period, and not a single case was reported. It seems likely, therefore, that the cases were found here because of increased surveillance.

Ackerman et al[4] observed a seasonal incidence, with most cases in the winter and spring, but the recent cases appear to have been more than just a variation of a seasonal pattern. The Center for Disease Control is currently compiling additional information to clarify this possibility and to determine the source of infection for hamsters sold by this supplier. Preventive measures must await the results of that investigation.

Alan Hinman, MD, and Victoria Smith, MD, gave permission for the use of information about Albany cases.

George D. Schryver, MD, did the IFA testing, and Walter Decher of the Virology Laboratories, New York State Health Department did the CF testing.

The complement-fixing antigen was provided by William Kinch and Edward Siroka, Division of Laboratories and Research, New York State Department of Health. Plaque neutralization was performed by William Kinch, according to the method of Hotchin and Kinch.[21] John Hotchin, MD, Division of Laboratories and Research, New York State Health Department, gave information on methods of viral isolation.

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