ilar habits. For instance, the Hopi Indians' only important source of wild animal protein is reported to be rabbit and, to a limited extent, deer and quail (*21*). It seems quite clear that prairie dogs and rabbits constitute an important food source. The fatal case of plague in 1963 at Houck, Ariz., was associated with rabbits caught for food during sheepherding. In the winter, when prairie dogs hibernate, the rabbit becomes an important epidemiologic link in the chain of *P. pestis* infection reaching from wild rodents to man (*5*).

The intimate association of the Navajo Indians with prairie dogs and other mammals is not limited solely to their use as food. Abundant evidence was obtained that Navajo children trap prairie dogs as a form of play, and we were told that children handle "pet" prairie dogs. At a site near Gallup, a steel trap that had been placed by Indians was seen at a prairie dog burrow. This could have been set to capture a "pet" or to obtain food.

House dogs or sheep dogs also are a possible epidemiologic factor. The domestic canine population is at least equal to, if it does not outnumber, the human population. Most of these dogs are poorly fed and must continually forage for themselves. Rabbits and prairie dogs make up a portion of their diet and domestic dogs occasionally bring these wild mammals back to the home area. Domestic dogs have been implicated in cases of human plague via their association with small mammals, and these dogs as well as others not directly implicated have been shown to have significant *P. pestis* hemagglutination titers in their serums (table 7). Thus, dogs on the Navajo reservation and elsewhere may possibly act as a bridge for infected mammals or their fleas, or both. In this connection, dogs were seen hunting in prairie dog colonies where the animals had died from plague. The dogs would poke their heads into burrow openings, many of which contained fleas that were later determined to be infected with *P. pestis*. The transport of rodent fleas by dogs has been observed (*22*). An analogous situation involving domestic dogs, ticks, and tularemia was found recently on the Rosebud and Pine Ridge Indian Reservations of South Dakota (*23*).

The preceding brief exposition suggests that plague in the Navajo Reservation, and possibly in other reservations and areas where Indians live, has unique epidemiologic characteristics. Theoretically, Indians always have been subjected to plague, because the current consensus is that wild rodent plague has been entrenched in the Western Hemisphere since prehistoric times. The comparison of the location of Indian reservations in the Western United States with the distribution of sylvatic plague (fig. 4) shows areas of geographic coincidence that are pertinent to both an historic perspective and to a view of the current situation.

We conclude, based on evidence from the 1965 epidemic, that although observed cases of plague among the Navajos did not have a familial character, the cases nevertheless were community oriented on the basis of cultural and socioeconomic factors. Thus the 1965 cases of plague can be conceived as constituting a community cluster. We can postulate that plague will continue to occur among Navajo Indians when a certain level of the disease is present in wild rodent populations. If this characteristic is borne out by additional observations, much weight will be added to the hypothesis that the Navajo Indian community presents a special epidemiologic framework in relation to wild rodent plague that sets it apart from the epidemiologic situations that have become well recognized in the United States.

An Emergency Program To Control Plague

DEAN F. TIRADOR, M.D.
BRYAN E. MILLER, B.S., M.P.H.
J. W. STACY, M.P.H.
ALBERT R. MARTIN, M.D.
LEO KARTMAN, Sc.D.
RICHARD N. COLLINS, M.D.
ROBERT L. BRUTSCHÉ, M.D.

BECAUSE of certain unique features, discussed previously, the plague epidemic was a serious hazard to the local population. Thus for the first time in at least four decades emergency measures were applied to control an epidemic of plague in this country. The control operations were based on the epidemiologic, medical, and ethnologic information assembled

during the investigation of the circumstances concerning the six cases which occurred in McKinley County.

Epizootics of plague, especially among prairie dogs, occurred in a broader area extending from near Winslow, Ariz., eastward to Tinian, N. Mex., and from about 35 miles south of Shiprock to about 40 miles south of Gallup, N. Mex.

The area is a high, arid plateau, intersected by washes and deeper canyons with several timbered hill and mountain ridges. The summer of 1965 was marked by an unusual amount of rain, which permitted an abundant growth of the sagebrush and rabbit brush characteristic of the more level sections of the region. Though much of the affected area was within the boundaries of the Navajo Reservation, private land and the Zuni Indian Reservation also were involved. Gallup is the major population center of the region and, aside from a few scattered settlements, the remainder of the population is widely dispersed. Many Indian inhabitants speak only their native language, and communication is further hampered by long distances and poor roads.

Many tourists visit the area during the summer. The colorful Gallup Intertribal Ceremonial records about 30,000 paid admissions in mid-August, and the Navajo Tribal Fair in early September generally records about 60,000 paid admissions. These two gatherings were sources of special concern because of the plague. During August of each year, approximately 7,000 Navajo school children are transported to off-reservation schools in the West and Midwest. This mass movement of individuals from an infected area to other parts of the country also was a source of concern.

General Organization

The design of a short-term emergency plague control program evolved from a series of meetings held in August and early September 1965. Many agencies were involved because the outbreak occurred in two States and included private, Federal, and Indian reservation lands. Representatives of the Arizona and New Mexico State health departments, the McKinley County (New Mexico) Health Department, the Bureau of Indian Affairs, the Navajo Tribe, U.S. Army, U.S. Bureau of Sport Fisheries and Wildlife, as well as the Public Health Service's National Communicable Disease Center and the Division of Indian Health collaborated to define the content of the program, to agree upon division of responsibilities for action, and to establish channels of communication to assure coordination among agencies. The San Francisco Field Station was the chief consultant on basic plague ecology and control.

Efforts were concentrated in areas where human cases had occurred and in areas of known prairie dog die-off. In addition to epidemiologic and ecologic investigations, which were described previously, the program centered about medical surveillance and vector control. A health education and public information program supported both of these major activities.

Medical Surveillance

The objectives of the medical surveillance component of the program were early detection, prompt reporting, and early treatment of confirmed and suspect cases in human beings. To accomplish these objectives, the hospitals (two private and seven Public Health Service) and physicians in the area were alerted to the outbreak and provided with clinical résumés of the cases that had occurred, together with suggested treatment regimens and laboratory procedures to be followed for the identification of plague organisms. Physicians were encouraged to be highly suspicious of febrile illnesses and lymphadenopathy, and to institute specific antiplague chemotherapy on a presumptive basis at the time, or immediately after, the required laboratory specimens were obtained or the particular illness was confirmed as plague.

The general population was alerted to the existence of the outbreak in order to obtain wide cooperation toward early identification and investigation of all possible suspect cases. The nature of the disease, its mode of spread, and signs and symptoms were described in news releases for radio, television, and newspapers. The Gallup bilingual radio station broadcasted a special program, providing the local populace an opportunity to call in questions about plague. Persons with febrile illnesses were urged to consult their physicians.

The greatest risk of exposure existed among

the Indians, and because of a language barrier, the scattered distribution of this population segment, and a lack of access to the usual communications media, special efforts were directed at them. Traders, teachers, Bureau of Indian Affairs officials, and members of the Navajo tribal government were briefed on the situation and asked to pass the information to their Indian contacts. They were also asked to inform health authorities of reports of illnesses in the scattered Navajo camps and small communities. Public health nurses and other members of the health team abandoned most of their other duties in order to investigate all such reports and to spot check people living on the reservation and in the affected off-reservation areas. If illness was observed, the person was urged to report to a hospital or clinic for diagnosis. Transportation was provided when necessary. Because of the movement of children to off-reservation schools, information sheets which outlined the plague situation in the home area and alerted school officials to the clinical signs and symptoms were distributed to the receiving schools.

For both the Intertribal Ceremonial and the Navajo Tribal Fair, a first-aid booth was set up on the fair grounds. The booth was manned by a physician and kept open from the time of arrival of the first crowds in the morning until the end of the evening performance. All persons with illness were encouraged to report to the physician. Both these celebrations attract large numbers of Indians who camp around the periphery of the fair grounds. Roving teams of public health nurses made regular tours through the areas of encampment, providing information about plague and also looking for sick people. Sick persons were referred to medical care facilities located on the fair grounds. Mimeographed information sheets were distributed at special exhibits.

The wisdom of conducting an immediate mass immunization program against plague was considered in detail. From an administrative point of view, previous experience with the Sabin Sunday program had indicated that an intensive publicity campaign would be necessary to obtain cooperation of the population, and, even if time had been available, the response would probably not exceed 35 percent of the total population. From an immunological point of view, the only readily available vaccine required two injections, spaced 1 month or more apart with a lag of 2 or more weeks after the second injection before appreciable antibodies could be expected. The consensus was that the emergency would have passed before an immunization program would be effective, although immunization may be considered in a longer range program.

Vector Control

A flexible program of insecticidal dusting and prairie dog control was established. Activities were to be centered in the areas surrounding the places where human cases occurred and at the ceremonial grounds in Gallup and the fair grounds in Window Rock where large crowds were expected. However, the occurrence of additional human cases or the finding of positive plague specimens among the wild animal population would signal additional areas to be treated. The Vector Control Section of the New Mexico Department of Public Health assumed primary responsibility for control activities in the affected off-reservation areas, while the Public Health Service's Office of Environmental Health, Division of Indian Health, had a similar responsibility for the on-reservation section. A U.S. Army vector control team treated affected areas of the Fort Wingate Ordnance Depot. Special teams were hired and trained to implement the vector control program.

Because the prairie dog is a source of food for the Navajo, we decided that better cooperation would be obtained on the Navajo Reservation if prairie dog control were limited and the major effort directed at flea control. Endorsement of the vector control activities was obtained from the Navajo Tribal Council before the program was started.

Control activities in the off-reservation area centered around the town of Gallup, eastward along Highway 66, and extending north toward Tinian and Long Lake (the sites where cases 3, 4, and 5 had occurred), as well as the areas immediately north and south of Gallup where cases 1, 2, and 6 had occurred. The control areas included camping sites used by visitors to the Intertribal Ceremonial and places surrounding all off-reservation schools in McKinley County.

The insecticide chosen was 5 percent malathion dust since it was readily available and could be applied in a concentration of 0.5 pound per acre, thus permitting the control teams to proceed rapidly through a large area. After preliminary insecticidal dusting, prairie dog burrows were fumigated with carbon bisulfide gas in situations where the colony was located near places of human habitation. In more remote locations, grain treated with 1080 was used to poison prairie dogs.

By the end of the emergency program in October, we estimated that approximately 100,000 prairie dog burrows had been dusted by hand, and well over 100,000 prairie dogs had been poisoned. Insecticide had been applied to about 700 acres of camping area, using a Gustafson power duster mounted on a 4-wheel-drive vehicle operated by a two-man crew.

While the on-reservation control program, which extended westward into Arizona, placed less emphasis on prairie dog poisoning, a limited amount of control work was done, especially where an active prairie dog town was located on school grounds. The on-reservation activities included insecticidal dusting of hogans and houses located in areas of active rodent die-off. Domestic dogs in these areas were dusted with malathion in an attempt to kill their fleas. By the time activities were completed, more than 1,000 homes had been dusted and more than 1,500 domestic dogs had been treated with insecticide. Prairie dog colonies in 23 separate areas of the Navajo and Zuni reservations were dusted. Prairie dog control with carbon bisulfide had been instituted in four areas. Before the Navajo Tribal Fair, the grounds were treated with 5 percent malathion dust at 0.5 pound per acre. The surrounding areas of encampment also were dusted and visitors were encouraged to camp in the treated areas. As results of field investigations of epizootics became known, vector control teams were shifted from area to area to give priority to those sections which appeared to present the greatest hazard to human health.

Public information and health education activities were designed to achieve acceptance of the program by residents of the affected areas, as well as to alert the population to the dangers of contact with prairie dogs and other small wild mammals. The population was encouraged to report die-offs of prairie dog colonies to local authorities.

Discussion

The emergency program had to meet the criteria of technical adequacy in terms of the disease and acceptability in terms of the population at risk. It was designed to cope with the most likely eventualities and to mobilize the available resources of the region to prevent spread. The death of one child with secondary plague pneumonia and the possibility of pneumonic spread lent urgency to the institution of control measures.

It is difficult to evaluate the success of the measures taken. Although no cases occurred after the completion of the control program, the onset of cold weather early in the fall undoubtedly contributed to a diminished contact between man, vertebrate hosts, and flea vectors of the infection. The effect of the surveillance program in bringing people to medical attention cannot be evaluated. The population undoubtedly was aware of the situation because there were self-referrals to health facilities by persons concerned that they might have the disease. There were numerous telephone calls about symptoms and about control measures. Excellent cooperation was achieved in the vector control program. The awareness of the population was achieved without panic, and, considering the potential seriousness of the outbreak, the number of rumors and the amount of misinformation were kept at a minimum.

The program emphasized the control of flea vectors in prairie dog burrows and also the application of insecticides to homes and other areas where large numbers of people lived or congregated. This is consistent with the principle established during World War II that flea control per se is an important measure in combating plague (*24*). Successful plague control based upon antiflea measures has been recorded from Peru, Palestine, and India. Brief summaries of the literature on plague control have been published (*25*, *26*).

No cause and effect relationship between the epidemiologic situation and the control efforts can be definitely established. Nevertheless the control program must be placed in the context

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of an epidemic situation in which field investigations revealed infection with *P. pestis* in many prairie dog colonies and in fleas collected from prairie dog burrows. Thus, a combination of insecticidal dusting, prairie dog poisoning, medical surveillance, and antiplague propaganda may have had a salutary effect upon the situation.

Summary

In a 1965 epidemic of bubonic plague among Navajo Indians in New Mexico, a total of six cases occurred in children between June 21 and September 1. This was the largest epidemic of plague in the United States in a single year since 1924. Epidemiologic investigation established a history of close contact with prairie dogs for five of the victims. One child died, and evidence of secondary plague pneumonia was found at autopsy.

The epidemic was the largest recorded in which each case in a human being was associated with a separate infective source in wild rodents. The cases occurred at a time when epizootics of plague were occurring among prairie dogs (*Cynomys gunnisoni zuniensis*) in New Mexico and Arizona.

Specimens from prairie dogs found dead, fleas from prairie dog burrows, and some fleas from field mice were infected with *Pasteurella pestis*. A cottontail rabbit, *Sylvilagus nuttallii*, was found dead from plague within the limits of a prairie dog colony undergoing an epizootic.

Serologic tests showed that domestic dogs in the affected areas had significant *P. pestis* antibody titers. None of the serums tested from wild rodents was positive for antibodies.

Evidence obtained during the study suggests that a combination of cultural and socioeconomic factors peculiar to the Navajos creates favorable and unique circumstances which make them far more likely than non-Indians to contact infective sources. Although the cases of plague in the Navajo children were not characterized by familial clustering, they can be considered a community cluster. Hypothetically, therefore, the Navajo Indian community represents a situation in relation to wild rodent plague that is different from the commonly accepted epidemiologic view in the United States.

During the summer of 1965, Federal, State, and other agencies concerned collaborated in a short-term emergency plague control program. The major activities consisted of medical surveillance, vector control, and public education.

Prairie dog burrows were dusted with 5 percent malathion and prairie dogs were poisoned. Domestic dogs, Indian homes, ceremonial grounds, camping areas, and other areas where people congregated were treated with insecticide. Emphasis was placed on sites where the plague victims lived and where they were known to have contacted infective natural hosts.

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Inaccurate Audiometers Hamper Screening Programs

Medical authorities at the Public Health Service's National Center for Chronic Disease Control believe that the use of inaccurate audiometers to measure hearing ability and detect ear damage or disease is widespread in hearing conservation programs across the country. They are backed by the findings of a 3-year Public Health Service evaluation of audiometers recently completed by the University of North Carolina's Audiometric Calibration Center which rated the accuracy of 100 audiometers. Not one of the instruments met the study's calibration specifications.

The National Center for Chronic Disease Control is concerned about the medical implications involved. An audiometer that is out of calibration can cause serious errors in large-scale screening programs. It can, for example, miss the child with a potentially dangerous infection of the middle ear or indicate an infection in another child in whom it does not exist.

For the next several months, the calibration center and the Neurological and Sensory Disease Control Program will conduct a followup study on the 100 audiometers that were tested and calibrated. The instruments will be examined at 3-month intervals to determine how often they need to be recalibrated, why they go out of calibration, and which functions of the instruments give the most trouble.

At the same time, the Neurological and Sensory Disease Control Program is negotiating with nongovernment contractors for the construction of a model audiometer, free of the defects discovered in the study instruments. Among other improvements, and unlike any audiometer now on the market, it will be self-calibrating.

A Case of Phocomelia—*Clinical Report*

CONGENITAL absence of the limbs in the newborn frequently has been reported. However, no pattern of development for any variety of these deformities has been observed. Symmetrical absence of upper or lower extremities is quite rare, and absence of arms is less rare than absence of the legs.

When the hands or feet are attached to the trunk by a single, small, irregularly shaped bone, the condition is called phocomelia. A recent birth of a phocomelus, who appeared normal in all other respects, is described with a discussion of his gestational history.

History

The mother was 23 years old, Negro, and having her fourth child. The infant, delivered at term after breech presentation, was a boy weighing 5 pounds 11 ounces. He had gross deformities of the upper limbs. The mother's last menstrual period began November 17, 1965; delivery was August 16, 1966.

Her previous pregnancies were in 1961, 1963, and 1964, and all three terminated with spontaneous, vaginal deliveries. The second child, born in 1963, had a mild degree of hypospadias. During that pregnancy the mother had severe monilial vaginitis, lasting from the third to the seventh month. Treatment was in the form of vaginal suppositories. During the fourth pregnancy the mother had a similar episode of vaginitis but was not treated because she feared using medications which she believed might be harmful to the baby.

Also, during the first 2 months of the fourth pregnancy, the mother had a severe infection of the upper respiratory tract, but she took no specific medicine. During the eighth week she bled from the vagina and had cramps in the lower abdomen for 1 day.

Her other medical history was not unusual except for a urinary tract infection between the second and third pregnancies. No urinary tract infections were evident during the actual periods of gestation.

A mild state of diabetic disease in both parents and a diabetic grandmother are reported in the immediate family's history. The parents were reported to have had elevated blood sugar levels, and the grandmother had taken Orinase tablets for several months in 1964. Neither the parents nor the grandmother had ever received insulin. The father of the baby was 23 years old and appeared in good health. No unusual or frequent X-ray exposures of either parent were reported.

Observations

Obvious malformations of the newborn infant were limited to the upper extremities and consisted of markedly short arms, just 2.5 cm. long, with angulation of the wrists so pronounced that the wrists seemed to arise almost directly from the trunk. His hands appeared to be fully developed.

Roentgenograms confirmed that the dwarfed condition of the arms was due to severe hypoplasia resulting in shortening of the humeri and absence of radial bones. There was no elbow joint, and the ulna was rudimentary. These conditions existed bilaterally. Roentgenograms of both legs showed no abnormalities in the bones.

Comment

Although no specific known teratogenic drugs could be incriminated with assurance in this case, Dr. W. Lenz has stated that a low risk of malformation is not precluded when pregnant women take any drug in common use ("Malformations Caused by Drugs in Pregnancy," *American Journal of Diseases of Children*, vol. 112, No. 2, August 1966, pages 99–106).

A continuous rise in the incidence of congenital malformations has been reported ("Birth Defects," edited by Morris Fishbein, M.D., J. B. Lippincott Co., 1963). Consequently, more intensive study of the etiology of birth defects is necessary, and more adequate reporting of these defects must be established.—SEYMOUR KREVSKY, M.D., *department of pediatrics, Detroit Memorial Hospital, Detroit, Mich.*