The 1952 Outbreak of Encephalitis in California

Epidemiologic Aspects

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• *For the most part, epidemiologic phenomena observed in the outbreak of encephalitis in 1952 accorded with patterns that had been apparent in previous years. Ninety-seven per cent of the 414 laboratory-confirmed cases of western equine and St. Louis encephalitis in humans occurred in the 20 Central Valley counties. The cases of western equine encephalomyelitis in horses were generally scattered over the state. In the Central Valley most of the cases in horses were in animals less than two years of age; elsewhere the incidence was higher in older horses.*

There were no laboratory-confirmed cases of western equine or St. Louis encephalitis in humans earlier than June or later than October.

In 1952 there were far more cases of western equine than of St. Louis encephalitis—a departure from the pattern in the previous seven years when there were about as many of one as of the other. No known satisfactory index is available for the prediction of the extent or type of outbreaks in humans.

Approximately one-third of the cases of western equine encephalitis were in patients less than one year of age, whereas there were no cases of the St. Louis disease in patients that young.

The incidence of western equine encephalitis in persons under 5 years of age was about the same for girls as for boys. In higher age brackets, males with western equine encephalitis outnumbered females 2 to 1. The corresponding ratio for St. Louis encephalitis was only 1.2 to 1.

CALIFORNIA EXPERIENCE with western equine and St. Louis encephalitis in man for the period 1945-1950 has been set forth in some detail by Lennette and Longshore,[4] and a general description of the 1952 outbreak has likewise appeared in print.[2] The purpose of this presentation is to touch on some of the epidemiologic highlights of the 1952 epidemic. It will not attempt to discuss either the environmental and climatic conditions, which were in a large measure responsible for the unusually heavy incidence in 1952, or the measures taken to control the outbreak. These factors and aspects are covered by Stead and Peters.[8]

The rather extensive epidemiologic data available for analysis were made possible by the assistance rendered by personnel assigned to California by the Communicable Disease Center of the United States Public Health Service, and through the cooperation of local health agencies and practicing physicians in the affected areas of the state.

The 1952 incidence of 805 cases of encephalitis in humans was the highest ever known in California. The total number of infectious encephalitis cases considered to be in the outbreak, and reported during the period June through October, was 792. Of these, 370 were confirmed by laboratory procedures as western equine encephalomyelitis and 44 as St. Louis encephalitis, making a total of 414 laboratory-confirmed cases (see Lennette and coworkers[5]). In 1950, the year of second highest incidence, the total number of cases was 357 of which 157 were confirmed; and in 1945, when the incidence was third highest, 54 of the 302 reported cases were laboratory-confirmed.

During the period May through November 1952, there were 407 cases of encephalitis in horses reported. Although the laboratory received specimens in relatively fewer of the cases in horses than of the cases in humans, 73 of the 407 were confirmed as western equine encephalomyelitis, and these occurred from June through September.

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GEOGRAPHIC DISTRIBUTION

Figure 1 shows the geographic distribution by county of the 805 cases of infectious encephalitis reported in 39 of the 58 California counties in the calendar year 1952. Figure 2 shows the areas report-

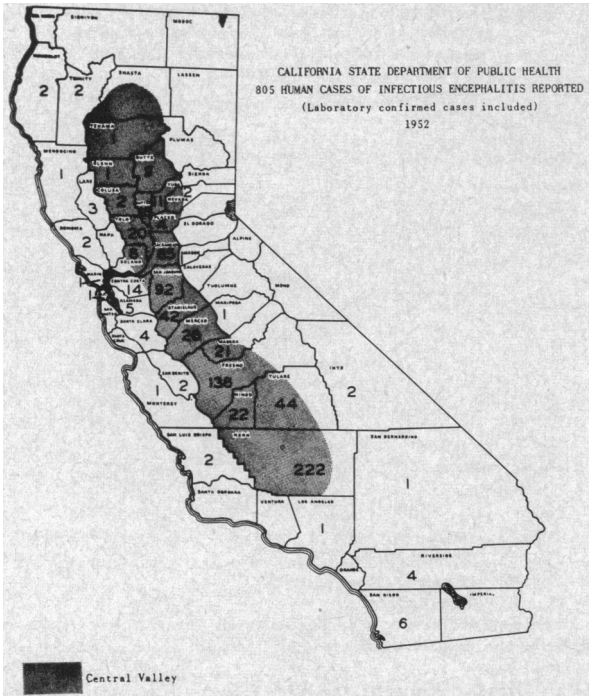

Figure 1

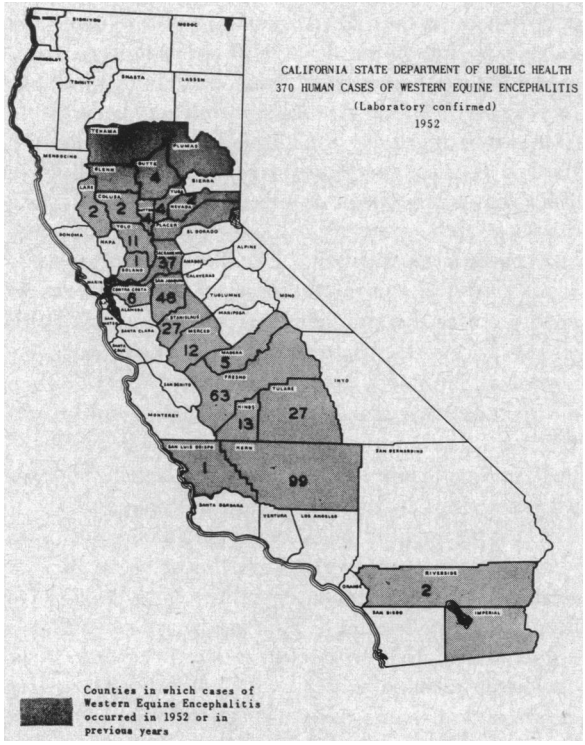

Figure 2

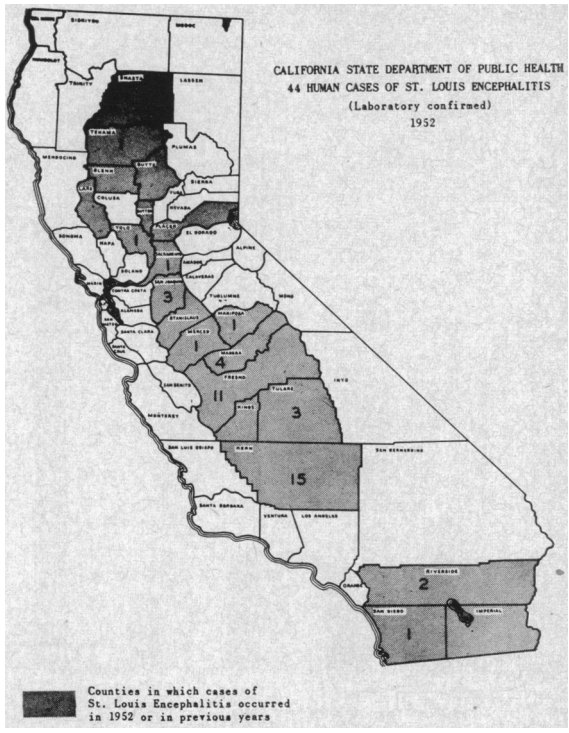

Figure 3

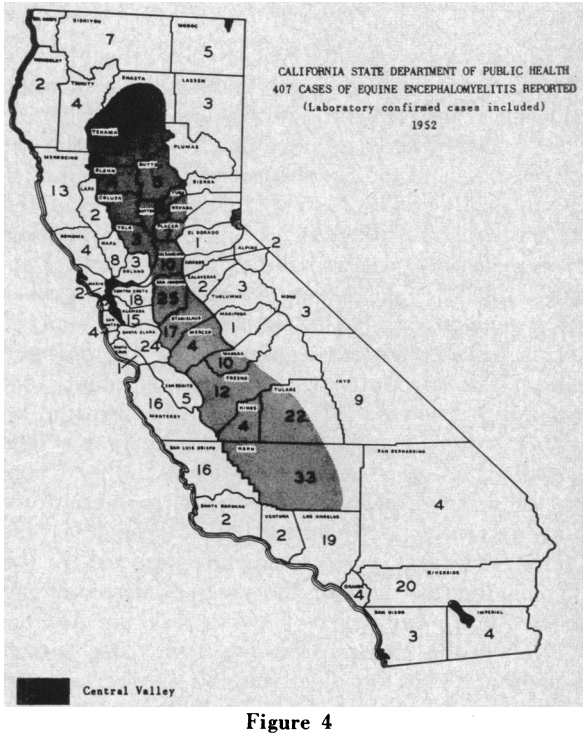

Figure 4

ing confirmed western equine encephalitis and Figure 3 those reporting confirmed St. Louis encephalitis. Twenty-three counties, predominantly those in the Central Valley, had laboratory-confirmed cases: 11 counties had western equine cases only, three St. Louis only, and nine had both types. Four counties had confirmed cases of western equine for the first time while three counties had their first confirmed cases of St. Louis encephalitis. Five of the counties in which cases were reported had not had any confirmed cases until 1952. These were: Mariposa, Nevada, Contra Costa, San Luis Obispo, and San Diego.

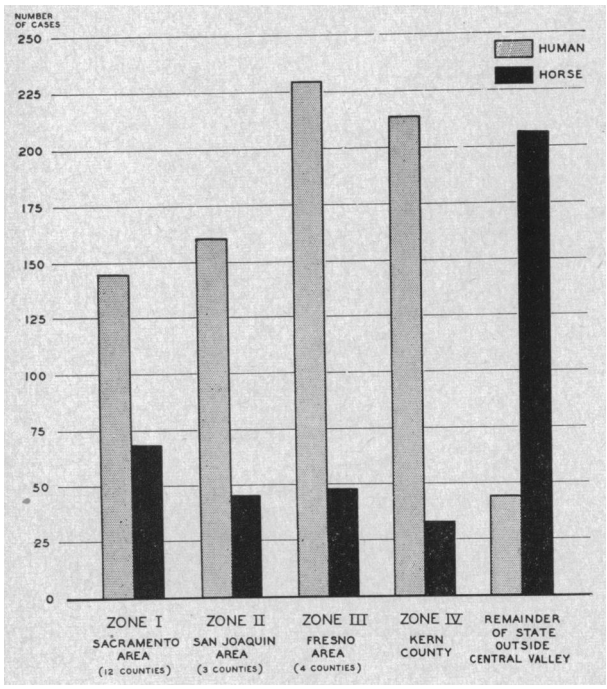

CHART 1

The pronounced differences in the ratio of cases in humans to cases in horses in the valley and in the "fringe areas" are shown in Figure 4 and Chart I. The major difference noted in the distribution of the human and the horse cases was that the majority of the human cases were rather definitely limited to the Central Valley area whereas the horse cases were generally scattered throughout the state. During the 1952 epidemic, approximately as many cases of encephalitis in horses were reported in some of the so-called "fringe counties" as in the endemic areas. This may have been due to the possibility that a large percentage of the horses in the endemic areas either had immunity due to exposure in previous years or had been vaccinated, whereas in the "fringe areas" a higher percentage of the horses were probably susceptible and vaccination in those areas was not started until actual cases were reported. In the endemic areas, most of the cases occurred among horses up to two years of age while those that occurred in the "fringe areas" were in older horses, suggesting that the older animals in the endemic areas had been exposed and had developed immunity whereas those in the "fringe areas" had not been exposed previously and were not immune.

The disease in horses follows an epidemiologic pattern similar to that in man. Very rarely does more than one case occur on any one ranch although there may be 10 to 20 other horses there. The cases occur sporadically and at widely scattered places.

TABLE 1.—*Reported human and equine cases of infectious encephalitis—month of onset by geographic zone of exposure—California, May-October 1952*

	Total	May	June	July	Aug.	Sept.	Oct.
Total							
Human	797	5	43	329	296	96	28
Horse	406	4	100	160	118	16	8
Zone I							
Human	146	..	1	39	87	15	4
Horse	70	2	53	15	....	....	....
Zone II							
Human	160	..	4	70	72	12	2
Horse	46	..	2	35	8	....	1
Zone III							
Human	230	..	9	105	75	32	9
Horse	48	..	10	27	10	....	1
Zone IV							
Human	217	3	28	104	42	30	10
Horse	33	..	22	6	5	....	....
Fringe Counties							
Human	44	2	1	11	20	7	3
Horse	209	2	13	77	95	16	6

Zone I—Sacramento area (12 counties).
Zone II—San Joaquin area (3 counties).
Zone III—Fresno area (4 counties).
Zone IV—Kern County.
Fringe counties—remainder of State outside Central Valley.

The transmission of the virus from horse to horse, horse to human, or human to horse has not been established. It has been stated that the usual sequence is that horse cases will occur one to three weeks before the onset of cases occurring in humans (see Table 1). This relationship has not been found to be uniformly true in California since in some instances human cases are reported first, while in others cases have been reported in both humans and horses at approximately the same time, with no definite pattern established. Usually the horse cases occur early in the southern area and then extend northward as the summer progresses; however, this is not always the pattern, as cases have been reported as far north as Tehama County earlier than in the southern San Joaquin Valley counties. In 1952, a large number of horse cases were reported in Riverside County late in August when horse cases were receding in the San Joaquin Valley.

An experimental study developed from the opinion held by many investigators that a horse ill with western equine encephalomyelitis is a hazard to humans in his vicinity. This study[1] showed that a horse inoculated with the western equine virus developed viremia as early as 24 hours after inoculation and in some cases the viremia lasted up to five days. Approximately seven to nine days after the horse was inoculated and four days after viremia was no longer present, rises in temperature were noted and about the tenth or eleventh day the horse became clinically ill. The fifth day following inoculation, the virus could be found only in the brain tissue. This indicated that the infected horse did not present any hazard to people or to other

horses after the appearance of the signs of clinical illness. It also demonstrated that since the viremia lasted up to five days, mosquitoes theoretically could bite the horses during this five-day period and in turn possibly transmit the disease to other horses or humans. This point is far from completely settled.

In a serologic survey approximately 30 to 40 per cent of the horses two years of age or older in the San Joaquin Valley showed evidence of St. Louis antibodies. Despite efforts over a period of years, no one has found a horse under natural conditions with clinical illness due to the St. Louis virus. Therefore, until proven otherwise, it is believed that under natural conditions the St. Louis virus does not cause clinical illness in horses.

There is no clear-cut explanation of the difference in the geographic distribution of human and horse cases, although several hypotheses have been put forth. One possibility is that, since high mean temperatures such as those in the Valley areas apparently are necessary for the development of the virus and its multiplication in mosquitoes, mosquitoes in coastal counties and other areas where high temperatures are not maintained would usually be noninfective. Another hypothesis postulates the presence of a non-mosquito vector that has a preference for horses and that could transmit the disease to horses in the "fringe areas," whereas within the Valley the mosquito species is the primary vector for both man and horse. However, adequate epidemiologic study of outbreaks among horses in the "fringe areas" may confirm the suspicion that most of the cases among the horses in these outer areas are in small valleys where the climatic conditions and mosquito prevalence fit the Central Valley pattern but neither the surrounding mosquito vector reservoirs nor human population provide sufficient exposures to give rise to cases in humans.[7]

TABLE 2.—*Cases of infectious encephalitis reported by counties and zones—California, 1952*

County	1950 Population	Total Cases—Number	Total Cases—Rate
California, Total	10,586,225	805	7.6
Central Valley, Total	2,097,204	758	36.1
Zone I:			
Butte	64,930	9	13.9
Colusa	11,651	2	*
Glenn	15,448	1	*
Placer	41,649	4	*
Sacramento	277,140	65	23.4
Shasta	36,413	.....	.....
Solano	104,833	8	7.6
Sutter	26,239	16	61.0
Tehama	19,276	1	*
Yolo	40,640	20	49.2
Yuba	24,420	11	45.0
Total, Zone I	662,639	137	20.7
Zone II:			
Contra Costa	298,984	14	4.7
Merced	69,780	26	37.2
San Joaquin	200,750	92	45.8
Stanislaus	127,231	42	33.0
Total, Zone II	696,745	174	25.0
Zone III:			
Fresno	267,515	138	51.6
Kings	46,768	22	47.0
Madera	36,964	21	56.8
Tulare	149,264	44	29.5
Total, Zone III	509,511	225	44.2
Zone IV:			
Kern	228,309	222	97.2

* Number of cases too small for rate computations.
Note: Rates per 100,000 population (1950 Census).

INCIDENCE

When the rate of incidence in humans is calculated for the Valley counties in the four zones, it is evident that the highest rate was in Zone IV (Kern County) where it was 97 per 100,000 population. Second was Zone III (Fresno, Kings, Madera and Tulare counties) where the rate was 44 per 100,000. In Zone II (San Joaquin, Merced, Stanislaus and including Contra Costa County) it was 25 per 100,000, and in Zone I (Butte, Colusa, Glenn, Placer, Sacramento, Shasta, Solano, Sutter, Tehama, Yolo and Yuba) it was only 20 per 100,000. Zones I, II and III are about equal in population, while the population of Zone IV is about one-third that of the other zones. If counties in the zones are considered individually, more variation in population, in number of cases and in rate of incidence is noted, as shown in Table 2.

The rate of incidence of encephalitis in infants less than one year of age varied considerably from zone to zone: It was 102 per 100,000 in Zone I, 290 in Zone III, 377 in Zone IV and 406 in Zone II. In all zones the rate of incidence in infants was higher than in persons of any other age group.

Even though large numbers of horses are vaccinated each year, which should bring about a reduction of the proportion susceptible to the disease, the rate of incidence was much higher in horses than in humans. This may be explained on the basis that horses are either more susceptible to the disease or that they have a greater exposure both as to the number of vectors and the area of unprotected skin. The incidence in California in 1952 was 384 per 100,000 horses (estimated).

SEASONAL PATTERN

The seasonal pattern of incidence in both humans and horses was essentially the same in 1952 as that observed in the preceding ten years. The incidence of western equine encephalitis in humans for the

state as a whole ranged from below ten cases a week for the first three weeks of June to a peak of over 100 cases a week in July, then receded to fewer than ten cases a week following the second week in October.

Fifty-three per cent of the western equine cases occurred in July, 60 per cent of the total for the year having occurred by the end of that month—this before any emergency mosquito control measures were put into effect. Ninety-four per cent of the western equine cases had occurred by the end of August, whereas only 20 per cent of the St. Louis cases had occurred up to that time. Fifty-two per cent of the St. Louis cases occurred in September.

Although specimens from patients with the encephalitis syndrome are tested at the laboratory at all times of the year, laboratory-confirmed cases of either type have not been recognized outside this June through October period of activity (with the exception in 1952 of an equivocal case with onset November 15).

The horse cases followed the same general seasonal pattern. The peak for the state as a whole was 160 cases, in July. In the Sacramento area and the Kern area the peak was recorded during June.

Once again the difference in seasonal pattern between western equine and St. Louis encephalitis in humans was noted. The first cases of laboratory-confirmed western equine had onset in June. The incidence reached a peak in July, decreased slightly in August and sharply in September. Confirmed cases of St. Louis type began in July; the peak was reached in September and there were a few scattered cases in October.

The ratio of cases of the western confirmed to St. Louis confirmed alternated irregularly during the eight years 1945-1952. In four of the years there were more western equine than St. Louis cases, and in the other four the converse, with no pattern of either sequence or alternation. Hence there is no basis for prediction as to which virus will predominate. Until 1952 there were no great differences between the number of western and the number of St. Louis cases in any year except 1947 when the ratio was 5 to 1.[4] In 1952, however, the ratio of confirmed cases of western equine to confirmed cases of St. Louis encephalitis was about 8 to 1. Also it should be noted that the number of confirmed cases of St. Louis encephalitis in 1952 was the second highest in the last eight years, the total of 44 cases comparing with the record high of 69 cases in 1950. This raises question as to whether mosquito control measures begun in August of 1952, specifically directed toward the Culex tarsalis mosquito, might not have reduced the number of vectors too late to have much effect on the outbreak of western equine encephalitis but soon enough, in

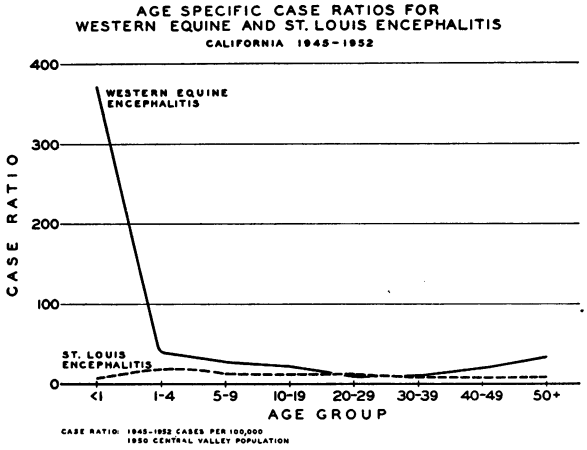

CHART 2

light of the difference in seasonal incidence, to hold the number of cases of the St. Louis disease to less than it might have been. In other words, without the control measures, would the incidence of St. Louis encephalitis and western equine encephalitis have been about equal, as in preceding years?

Upon analysis of another facet of seasonal data for 1952, it was noted that the peak of incidence of western equine encephalitis in humans occurred earliest in the southern part of the Central Valley, later in the mid-central and then in the northern central portions of the Valley. In 1952 for the first time cases occurred in sufficient numbers to demonstrate this phenomenon. This progression northward is probably owing to progression of climatic changes, not to a migration of infected mosquitoes or a movement of infected persons up the Valley.

AGE DISTRIBUTION

In all areas in which western equine encephalitis occurred, the incidence was far higher in infants less than one year of age than in any other age group (Chart 2). Approximately one-third of all patients were in that age bracket, and 94 per cent of those in that group were under seven months of age.

In 1952 there were no cases of St. Louis encephalitis in persons less than a year of age; and of the 213 confirmed cases of the disease in California in the eight years 1945-1952, only three (1.4 per cent) were in patients in that age bracket, whereas 29 per cent of all cases of western equine encephalitis were in the lowest age group. Studies are under way to explore the possibility that (1) antibodies for the St. Louis virus are more effectively transmitted from mother to fetus than are western equine antibodies, or that (2) many more mothers are immune to St. Louis than to the western equine virus.

SEX AND RACE

Of the 792 cases of infectious encephalitis reported in the period June through October 1952,

TABLE 3.—*Results of tests to determine number of subclinical cases of St. Louis or western equine infection in members of family of patient with disease*

	No. Persons Tested	Laboratory Results		
		Negative	Antibodies Present*	Unsatisfactory Tests
Zone I, Sacramento area (12 counties)	259	248	10	1
Zone II, San Joaquin area (3 counties)	361	342	9	10
Zone III, Fresno area (4 counties)	10	9	1	....
Zone IV, Kern County	55	53	....	2
"Fringe" counties outside Central Valley	4	3	1	....
Total	689	655	21	13

* For western equine. In no instance was there laboratory evidence of St. Louis virus antibodies.

535 were in males and 257 in females, a ratio of about two to one. This difference, previously observed, has been attributed by many investigators to the greater occupational hazards and exposure of males. In laboratory-confirmed cases of western equine encephalitis the ratio was about the same as for all cases of encephalitis reported—there were about twice as many male as female patients—but in the smaller series of confirmed cases of St. Louis encephalitis the ratio of males to females was only 1.2:1.

In the western equine infections, the difference in incidence by sex was pronounced in persons 5 years of age and older, but there was little if any difference in children under 5 years old. Of 31 patients in the 5 to 9 age group with proved western equine infection, 27 were boys and 4 girls—a disparity that can hardly be explained as owing to occupational factors.

Of the 792 cases reported, 708 were in white persons, 53 in non-whites and 31 in persons whose race was not reported.

SPECIAL SURVEYS

An attempt was made to determine the number of subclinical cases occurring in the family of a person with a proved case. Specimens of blood were taken from all persons in the same household with patients who had proved cases of either St. Louis or western equine encephalitis and the specimens were tested for the presence of antibodies which might indicate recent or previous infection with either of the viruses. The results (Table 3) may be interpreted to indicate that multiple clinical cases in a family are unusual even though members of the family other than the patient rarely exhibit antibodies in their blood.

Specimens of blood were submitted for laboratory tests in 91 per cent of the cases reported as encephalitis. But since there were many cases of clinical encephalitis in which laboratory tests for the etiologic agent were negative, there seems to be reason for strong surmise that viruses as yet unrecognized produce this familiar syndrome. The observation of some patients who had clinical symptoms typical of encephalitis but who had negative results of serology at the usual 10 to 14 day interval, brought about a special study of blood specimens obtained over a longer period. Additional cases were confirmed in the older age groups by this procedure.[3, 6]

At present, not often is suspicion of encephalitis aroused unless there are symptoms of central nervous system involvement. However, at two hospitals effort was made to get specimens of blood from all persons entering with fever; and in two cases in which the only symptom besides fever was diarrhea, serologic tests showed significant titer rises for the western equine virus. While the series on which the study was made was small, the results gave some cause for considering extension of the scope of suspicion to include symptoms other than those referable to the central nervous system. Further studies are indicated.

FATAL CASES

Of the 805 patients with reported infectious encephalitis in 1952, 52 died, a case fatality rate of 6.4 per cent. This compares very favorably with fatality rates in previous years when the number of cases was much smaller: 8.3 per cent in 1951, 8.9 per cent in 1950, 20.0 in 1949 and 42.3 in 1948. The 52 deaths in 1952 were, after investigation, ascribed to encephalitis, but in many instances the etiologic agent was not determined. The decline in case fatality rate may be the result of a combination of improved supportive therapy, better case finding, and changes in death recording.

Autopsy was carried out in 36 of the 52 fatal cases in 1952. In only 14 cases were specimens of the brain submitted to the Virus Laboratory in Berkeley. Western equine encephalitis virus was isolated from 5 of the 14, and 9 were reported as negative for western and St. Louis viruses. (Herpes virus was isolated from two and Coccidioides immitis from one of the specimens that were negative for the St. Louis and western equine viruses.)

Emphasis is needed on the desirability of submitting adequate autopsy specimens for viral tests.

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