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Neurotropic Infections With Special Reference to Equine Encephalomyelitis

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In many instances a given infectious disease common to one species has its counterpart in other host species. Some infections are host specific while others are not. In Table I it will be noted that human Pasteurellosis is the type representative of a number of similar infections in other species. In the case of Brucellosis, the three main types of Brucella organisms are capable of infecting at least five species of hosts.

The filterable viruses, like the bacteria, can be considered as falling into certain groups based upon the type of tissue or parts of the body that they attack. Some viruses affect the skin, while others may attack the blood, intestinal tract or the nervous system. A few of the infections involving the central nervous system will be considered.

The group of infectious agents known as filterable viruses, like the bacteria, present distinct differences among the individuals that make up this group. Some of the viruses are within the range of microscopic visibility while the majority are so small that they cannot be detected even with our most modern ultramicroscopic instruments. Some viruses are very resistant while others are readily destroyed. Each virus must be considered as an entity having certain characteristics which distinguish it from the others.

The elementary student of bacteriology and immunology is impressed quite early in his studies by the fact that a substantial host immunity can be produced readily by means of biological products prepared from some bacteria or their toxins. Diphtheria, anthrax, blackleg and typhoid are representatives of that group. On the other hand, this is not possible with many others. Tuberculosis is a good example. Koch produced “tuberculin” for the purpose of immunizing against tuberculosis. He failed in his primary objective and the product has since become a valuable diagnostic agent. In some instances antitoxins or immune sera which are specific and highly potent are ineffective when administered after considerable damage has been caused by the etiological agent. After the toxin has combined with the tissues of the central nervous system the highly potent and specific biologic agents are of little value. This is true, especially of the infectious agents and their toxic products that have an affinity for the central nervous systems. Tetanus and botulism are caused by bacteria which produce microscopic toxins of this nature.

The filterable virus causing human anterior poliomyelitis (erroneously referred to as infantile paralysis), the virus of equine encephalomyelitis (incorrectly referred to as sleeping sickness, the latter being caused by a trypanosome), and the virus of loping ill or ovine poliomyelitis belong to one group that can be classed provisionally as the polio viruses.

It is doubtful whether one veterinarian among several hundred who encounters outbreaks of equine encephalomyelitis realizes that he faces a problem analogous to that confronting the physician who deals with human anterior poliomyelitis. On the other hand, few physicians appreciate the similarity of the problems faced by the veterinarian dealing with equine virus encephalomyelitis. Nevertheless, the well known equine encephalomyelitis virus is in reality the companion virus of human anterior poliomyelitis. The histopathology is similar except for slight differences in the cellular responses. Much can be learned by considering these diseases from a comparative standpoint.

In thinking of equine encephalomyelitis
in international terms, four similar types of viruses are brought to mind:
1. Borna's disease virus
2. South American virus
3. Western U. S. virus
4. Eastern U. S. virus

**Seasonal Occurrence**

In general the seasonal occurrence of equine encephalomyelitis is almost identical with that of human anterior poliomyelitis and louping ill of sheep. Insect transmission has been suspected for a long time. Kelser (1) showed experimentally the ability of the Aedes aegypti (yellow fever mosquito) to transmit the western sollicitans is confined in this region. Following a severe storm encephalitis appeared in areas usually not seriously affected. The virus infected mosquito had been blown inland and was found in these areas. The movement of animals to and from the areas in which the disease occurs may also be a factor in the reported incidence.

In the western and midwestern parts of the United States, where the western type of virus appears, a high incidence of the disease has always been associated with the prevalence of many insects during or following wet weather. In Iowa, the summer of 1936 was very dry and hot. Very few insects were evident. In September considerable rainfall produced an abundant growth of vegetation. The first killing frost appeared very late in the fall. During the summer of that year practically no cases of equine encephalomyelitis occurred. However, in October of the same year, following September rains, a considerable number of relatively mild cases of encephalomyelitis appeared. There was a great abundance of rain in 1937 and a severe epizootic appeared.

The occurrence of equine encephalomyelitis in the middle west probably dates back to the past century. The term "Kansas horse disease" and other synonyms undoubtedly included the virus disease and one or more other conditions, the most important being leucoencephalomalacia or moldy corn poisoning. The first substantial evidence of the existence of the virus disease in Kansas and Nebraska in the summer of 1912 is recorded by Udall (5). The clinical and histopathological descriptions recorded by him are typical of equine encephalomyelitis. He failed to establish

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The Veterinary Student
the virus in experimental animals. This is not surprising. We demonstrated the field virus in only about 10% of the cases examined. This might be explained in part by the irregular distribution of the virus in the brain of the horse.

**Histopathology**

The histopathology of equine encephalomyelitis is characterized essentially by three cellular changes—a perivascular infiltration or cuffing, focal cellular infiltration and phagocytosis or infiltration of the motor cells. The latter change is indicative of nerve cell destruction and loss of function. In all probability a physiologic disturbance of many nerve cells, with loss of function, occurs which cannot be demonstrated by histologic technic at the present time. The virus is not always found in the same parts of the brain or throughout the entire central nervous system. The varying clinical manifestations are dependent upon the distribution of the virus and the accompanying lesions.

The conventional clinical pictures need not be reviewed here. Several workers have recorded a biphasic temperature reaction in equine encephalomyelitis. An early temperature response occurs during which time the virus appears in the blood. When the clinical symptoms appear the virus has usually disappeared from the blood. We have never been able to demonstrate the virus in the blood of clinically affected animals. At this time the damage has already been done to the central nervous system. Consequently treatment can only be symptomatic. A marked dehydration takes place quickly. This can be influenced favorably by the introduction of large amounts of water containing sugar or molasses. Excessive handling will do more harm than good. In the comparable human disease it has been recognized for many years that the degree of paralysis is favorably influenced by early rest of the affected members.

**Biological Control**

Various definitions of immunity are recorded. Time will not permit a discussion of this field except to state that immunity established by various procedures is relative, not absolute, and not always lasting. As pointed out previously, some biologic agents readily produce immunity, e.g., blackleg biologics. In the case of the neurotropic infections we are confronted by a very complex situation. The experience of the human investigators in poliomyelitis is of interest to us because of the similarity of the two diseases. It was thought that heat killed virus of poliomyelitis did not stimulate sufficiently the production of an immune state. An attempt was made to attenuate the virus to a point where it would still stimulate immunity but not cause a fatal infection. The question then arises—is the production of immunity due to attenuated virus or to a remaining sublethal amount of living virus? Much controversy prevails regarding the question as to whether or not a killed virus is capable of stimulating a substantial degree of immunity. Attention is directed to the past efforts to attenuate the virus of hog cholera. Experimental results obtained by attenuated human poliomyelitis virus seemed promising. It produced some immunity but in an alarming number of cases a definite paralysis followed the injection of the second immunizing dose.

The appearance of immune bodies in the serum of an individual does not necessarily mean that the central nervous system is immune. On the other hand, individuals may be immune to infections in the absence of antibodies in the blood. The recent studies of Sabin and Olitsky (6, 7, 8) illustrate the difficulty of defining the mechanism of immunity against the neurotropic viruses under field conditions.

Olitsky and Sabin, working with the virus of vesicular stomatitis, showed that as mice grow older they acquire a resistance to peripheral inoculation with Indiana and New Jersey strains of vesicular stomatitis virus and to some extent also to the Western U. S. equine encephalomyelitis virus but little or none to the eastern strain. Some mice are resistant as early
as the thirtieth day of life, while others may still be susceptible at one year. The resistance is readily demonstrable by intranasal, intramuscular, intraperitoneal and intravenous routes, but not when the virus is injected intracerebrally. The resistance described above by Olitsky and Sabin appeared in the absence of previous exposure or infection and it is not related to the presence of specific or non-specific antibodies in the blood. Young and old guinea pigs showed no difference in susceptibility to peripheral inoculation of pseudorabies. Relatively young and old Macacus rhesus monkeys were susceptible to poliomyelitis virus to a like degree. When young mice were injected intramuscularly with vesicular stomatitis virus they succumbed while older mice failed to react. However, when the virus was injected into the sciatic nerve of older animals it disappeared from the nerve after three days and made its appearance in the central nervous system. The ability of virus to invade the central nervous system from the nerve but not from the muscle suggests the existence of a barrier between a muscle or myoneural junction according to these workers' results. When the virus was injected into vitreous humor of eye a fatal encephalitis occurred in 15 day old mice. One year old mice with few exceptions survived.

One explanation for the above results given by Sabin and Olitsky is as follows: That in both old and young animals when the virus is injected intracerebrally it spreads by way of an open system, i. e., the ventricles and extensions—the lesions are found in the surrounding tissue. In old mice it is believed that the virus is unable to involve the terminal processes or cell bodies of the neurons at the site of inoculation. However, the facts do not apply to all viruses. These facts illustrate the complexity of neurotropic infections and immunity.

### Biological Agents

The efficacy of the equine encephalomyelitis immune serum is understood. The symptoms manifested by the disease are based upon impairment of function and destruction of nerve tissue. Immune serum cannot replace or repair that nerve degeneration. Its use is indicated early in some selected cases.

The brain vaccine (method of Shahan and Giltner) is made from artificially infected horses. The laboratory tests show very definitely that some protection was given the animals. Veterinarians are familiar with field results. Many of the elaborate statistical data are open to criticism. That animals treated with brain vaccine did not contract the disease subsequently does not necessarily mean that they would have become sick if not so treated. An unbiased evaluation of the data permits one to say that some degree of protection probably followed the brain tissue vaccination. It must also be noted that an embarrassingly large number of cases failed to withstand field exposure. A great number of horses in the middle west are resistant to infection. In attempts to infect experimental horses by lingual, cutaneous, subcutaneous and intranasal routes, we failed in the relatively small number of animals used. The eastern virus readily infects western horses, whereas western virus readily infects eastern horses. Ten Broeck et al (9) report that on farms where encephalomyelitis appeared, 17% of the clinically unaffected horses showed neutralizing antibodies in the blood. On farms located in the epizootic area where no clinical cases appeared, 14% of the horses showed neutralizing antibodies. The blood of a control group was negative.

### Chick Embryo Vaccine

The technic used in the production of chick embryo vaccine for encephalomyelitis is not new. In 1931, Woodruff and Goodpasture (10) used the chorio-allantoic membrane of the chick embryo on which to grow fowl pox virus. The procedure has many advantages, among which are the low cost of production and the ability to grow virus free from contamination. The exact technic used in the production of the chick embryo vaccine
has not been published in detail. The following procedure is in general use for the cultivation of viruses in eggs. The normal incubation period of the chicken egg is 21 days. Fresh eggs are cleaned and incubated for 7 days or more to permit the early embryonic development. By means of a dental drill, on which is mounted a small cutting wheel, a piece of shell is cut and lifted, exposing the shell membrane. The underlying membrane is scarified and inoculated with virus. The egg is sealed and incubated further to permit multiplication of the virus. This procedure is inexpensive and permits the production of a more concentrated virus than by the horse brain method.

It will be recalled that the virus is not present in all parts of the horse brain. The sales literature dealing with the chick embryo vaccine is very glowing and it claims unqualified superiority over the brain vaccine. Only the field veterinarian will confirm or disprove this.

No discussion of virus encephalitis is complete without calling attention to leucoencephalomalacia or moldy corn poisoning. This disease occurs in the horse during the late fall and winter, making its first appearance at corn picking time. The horses may present symptoms very much like the virus disease. With late frosts and a moist, moldy corn crop the occurrence of the virus encephalomyelitis and moldy corn poisoning may overlap. Moldy corn poisoning or leucoencephalomalacia can be readily diagnosed by a systematic examination of the brain, which will reveal yellowish edematous areas or varying sized areas of liquefaction necrosis.

References


STATISTICS SHOW SIXTEEN STATES REPRESENTED IN VET QUAD

A few years ago there was a notable shortage of matriculants at this and every other veterinary college in the country, but the present time sees applications for admittance much in excess of those admitted.

As to be expected, Iowans make up a good portion of the student personnel at Iowa State’s Division of Veterinary Medicine, with some 110 Iowa men enrolled. However, Minnesota citizens taking the course total 22, with Illinois running close behind with 20. Nebraska has 6 of her native sons enrolled and Missouri follows with 5. Eleven other states are represented in the Veterinary Division including Oregon, California, Florida, West Virginia, and New York.

The ages of the student enrolled in the division run from 18 to 34. The average ages for the four years are 21, 22, 23, and 24, respectively, for the Freshmen, Sophomores, Juniors, and Seniors.

The fathers of 34 of these students are veterinarians. The largest percentage are from farms, the number being 76. A greater number of the students, 151 in fact, have had work or experience with some phase of veterinary medicine.

In conducting a survey of the classes it was discovered that 145 intend to go into general practice. Small animal practice and government work run second and third choices. Other lines of work indicated were education, research, conservation, public health, and army service.