THE DISTRIBUTION OF SWINE INFLUENZA VIRUS IN SWINE

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Swine influenza is a disease of complex etiology. It is caused by the concerted action of a filtrable virus and the bacterium, *Hemophilus influenzae suis*; and neither agent alone is capable of inducing the disease (1).

While the virus of swine influenza has been found regularly in mixtures of lung and bronchial lymph nodes from infected pigs (1 and 2), it was not demonstrated, in a small number of earlier unpublished experiments, in either the spleen or heart blood by swine inoculation. Furthermore the virus was innocuous when administered intramuscularly to swine (3) and produced influenza only when it gained entrance by way of the respiratory tract. These facts are in accord with Waldmann's conception of it as a pneumotropic virus (4).

However, certain features of the clinical and pathological pictures exhibited by swine suffering an acute influenza suggest a generalized or septicemic infection rather than one in which the etiological agents (1) are limited to the respiratory tract. The prostration of infected swine is more extreme than might be expected from the amount of pneumonia encountered at autopsy, and the accompanying leukopenia (2) suggests the possibility of the presence of the infectious agents in the blood stream. At autopsy pathological alterations are encountered outside the respiratory tract: The cervical, bronchial and mesenteric lymph nodes are frequently enlarged and edematous, the spleen is usually swollen and engorged and the mucosa of the colon is congested and sometimes edematous (2). It was known from bacteriological studies that, except in fatal cases, *H. influenzae suis* was seldom encountered outside the respiratory tracts of swine ill of influenza (5). This organism could thus not be held directly accountable and it seemed possible that the filtrable virus might be responsible for the features of swine influenza suggesting a generalized infection.

The experiments reported in the present paper were conducted in an effort to determine whether the swine influenza virus was limited strictly to the respiratory tract or whether it became generalized during the course of the disease. The observation by Andrewes, Laidlaw and Smith (6) that the swine influenza virus is pathogenic for white mice has been utilized in this study of the distribution of virus in influenza-infected swine.

EXPERIMENTAL

The 8 swine used in the present experiments were infected by intranasal inoculation with glycerolated swine influenza virus mixed with a small amount of a culture of *H. influenzae suis* (2). All developed typical swine influenza and were killed with chloroform on either the 3rd or 4th day following inoculation. Portions of the organs to be tested for the presence of virus were removed at autopsy with sterile instruments. They were then ground with sand and physiological salt solution was added to make an approximately 5 per cent suspension. The suspensions were allowed to sediment for 10 minutes before the supernatant fluid was decanted to be used in inoculating mice. The tracheal exudate was scraped from the opened trachea with a sterile spatula and was prepared as an approximately 5 per cent suspension by shaking in a flask containing glass beads and physiological saline. Blood was obtained from the swine at autopsy by pipette from the seared heart. It was defibrinated with a wire whip and used undiluted in inoculating the test mice.

The white mice used in testing for the presence of virus in the various organ suspensions were inoculated intranasally, while under ether narcosis, as previously described (7). They were kept under observation for 4 days and the survivors were then chloroformed and examined for the presence of the characteristic pneumonia caused by the swine influenza virus (6 and 7). Some of the mice, especially those receiving tracheal exudate and lung, succumbed to the swine influenza virus infection on the 3rd or 4th day. Three mice were inoculated with each suspension in most cases. The results are summarized in Table I.

DISCUSSION

As shown by the data in Table I, swine influenza virus was present in the lungs, tracheal exudate and turbinates of all swine tested. It was demonstrated in only two instances in tissues outside the respiratory tract. One of each group of 3 mice inoculated with suspensions of the bronchial lymph nodes of Swine 1539 and Swine 1574 developed a scant influenzal pneumonia. To be certain that the lesions in these 2 mice were due to swine influenza virus their lungs were used to infect other mice in series; these mice all developed typical and extensive

TABLE I

The Distribution of Swine Influenza Virus in Swine

Swine No.	Extent of influenzal lung lesions produced in mice by swine tissues and materials tested											
	Lung	Tracheal exudate	Turbinates	Bronchial lymph nodes	Defibrinated blood	Blood serum	Spleen	Liver	Kidney	Mesenteric lymph nodes	Colon mucosa	Brain
1536	1, 2, 2*	2, 1, 2	2, 1, 0	0, 0, 0	0, 0, 0		0, 0, 0			0, 0, 0	0, 0, 0	
1532	2, 2, 2	4, 4, 4	1, 1, 1	0, 0, 0	0, 0, 0		0, 0, 0	0, 0, 0	0, 0, 0			0, 0, 0
1542		3, 2, 2	1, 1, 2	0, 0, 0	0, 0, 0		0, 0, 0	0, 0, 0	0, 0, 0			0, 0, 0
1539	2, 1, 3	3, 3, 3	3, 3, 1	1, 0, 0	0, 0, 0		0, 0, 0	0, 0, 0	0, 0, 0			0, 0, 0
1563	4, 3, 1	4, 4, 4	2, 2, 4	0, 0, 0	0, 0, 0		0, 0, 0	0, 0, 0	0, 0, 0			
1574	3, 4, 2	4, 2, 3	1, 1, 1	1, 0, 0	0, 0, 0		0, 0, 0	0, 0, 0	0, 0, 0			
1579-B	3, 1	1, 2	4, 3	0, 0		0, 0	0, 0	0, 0	0, 0	0, 0	0, 0	0, 0
1573	2, 3	3, 2	1, 0	0, 0		0, 0	0, 0	0, 0	0, 0	0, 0	0, 0	0, 0

* 0 = Mouse with no detectable influenzal lung lesions postmortem.
1 = Mouse with influenzal pneumonia involving upwards to 1/4 of lung at postmortem.
2 = " " " " " from 1/4 to 1/2 of lung at postmortem.
3 = " " " " " " 1/2 to 3/4 " " " " "
4 = " " " " " " 3/4 to all of lung at postmortem. Mice showing lung lesions to this extent usually died.

influenzal pneumonias. The bronchial lymph nodes of 2 of the 8 swine examined thus contained swine influenza virus but, as judged by mouse inoculation, in very low concentration. No virus was detected in the spleens, livers, kidneys, mesenteric lymph nodes, colon mucosae, brains or blood of any of the swine studied.

Mice inoculated intranasally with either the fresh defibrinated swine blood or swine serum exhibited a picture at postmortem which deserves special comment. Their lungs contained pale grey areas of consolidation that were similar in distribution to the lesions caused by the swine influenza virus. The possibility was at first entertained that these pneumonic areas might represent unusual virus reactions. However, all attempts to transmit virus serially in mice from such lesions were unsuccessful, the lungs of mice of the first serial transfer proving normal at autopsy.

No evidence was obtained to indicate that the swine influenza virus was generally distributed throughout the bodies of any of the 8 swine studied. It was confined to the respiratory tracts of 6 of the animals and in the remaining 2 to the respiratory tracts and the regional lymph nodes. The virus evidently has a strong affinity for the respiratory tract and exerts its specific effect there. Those features of swine influenza suggesting a generalized or septicemic infection appear, therefore, to be secondary effects of the localized respiratory tract disease.

SUMMARY

Swine influenza virus was found to be regularly present in the turbinates, tracheal exudate and lungs of infected swine but not in the spleens, livers, kidneys, mesenteric lymph nodes, colon mucosae, brains or blood. It was present in low concentration in the bronchial lymph nodes of 2 out of 8 animals. This localization of the virus in swine accords with its classification as a pneumotropic virus.

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