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Swine Erysipelas. Revised Edition of Research Bulletin 84

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Swine Erysipelas

Revised Edition of Research Bulletin 84
L. Van Es and C. B. McGrath
Department of Animal Pathology and Hygiene

LINCOLN, NEBRASKA
JUNE, 1942
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PREFACE

Because of the more or less frequent occurrence of swine erysipelas on Nebraska farms it seemed proper that information on this subject be made available in the form of a Station publication, especially written to serve as a reference for veterinarians, who naturally are first appealed to when an as yet relatively strange disease appears among a herd of swine. Hence the text is written in a technical form for the sake of precision.

In the preparation of the text the literature of countries in which for many years the disease has constituted a permanent problem has been freely consulted. It seemed wise to profit from the vast experience therein recorded without losing sight of the nature of your local situation and its as yet peculiar requirements.

L. V. E.
C. B. McG.

PREFACE TO REVISED EDITION

Since 1936 when Bulletin 84 was issued 5,000 copies have been distributed to persons interested in the swine erysipelas problem. The continuation of the demand for this publication made a new issue necessary. Advantage was taken of this opportunity to bring about revisions based on observations made during the past six years and to incorporate in the text some data relating to the disease and its control in Nebraska.

L. V. E.
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Swine erysipelas is a transmissible disease, caused by a specific microorganism, and manifests itself by certain acute and chronic phenomena.

HISTORICAL CONSIDERATIONS

It was not until the earlier days of bacteriology that swine erysipelas became recognized as a distinct entity among the disorders of swine. In various countries, names still current were applied to certain diseases of swine which suggest that the one under consideration may have been referred to. There is reason to believe that any disease in which redness of the skin was a prominent feature may have been included. Swine diseases of an apparently communicable nature, with a high rate of mortality, had thus far defied classification, and like those of other animal species, all available knowledge about them had for ages remained of a rudimentary and empirical character.

Even when, after the establishment of veterinary schools in the second half of the 18th century, attempts were made to bring clarity into the prevailing confusion, they failed because of the lack of appropriate methods of inquiry. The time had not yet arrived to bring such efforts to a definite conclusion, and hence it is not surprising that by a more or less common consent, the disease now known as swine erysipelas was accepted as a form of anthrax.

However, in spite of sanitary police regulations, European peasants continued to slaughter swine affected with the disease and to use their meat with apparent impunity. This gradually began to cause doubt in the minds of professional observers and about the middle of the forties of the 19th century it began to dawn on them that erysipelas was either a very special and unusual form of anthrax or that it was not anthrax at all.

The endless and tedious disputations on this question finally terminated with the discovery of the anthrax bacillus during the fifties of the century. It was then possible to demonstrate the absence of the anthrax rods in swine erysipelas blood and tissues as well as the failure to produce anthrax in animals inoculated with it. The etiology of the swine disorder was still in the dark, but its connection with anthrax could no longer be maintained.

This uncertainty terminated with the discovery of the erysipelas bacillus, by Pasteur and Thuillier (73, 74) in 1882–83. Their description of the organism may not be characteristic, but the fact that they used it successfully as a vaccine leaves no doubt in regard to their discovery. At about the same time, the organism was seen and studied by Loeffler (51) who, however, did not publish his observations until 1885. In this connection mention must be made of the discovery of the mouse septicemia bacillus (B. murisepticus) by Koch in 1879. This organism is now accepted as specifically identical with the swine erysipelas bacillus.

Lorenz (1892–1899) and Leclainche (1897–1900) succeeded in working out a practical method of immunization against the disease, which at this time is universally applied in the countries where erysipelas constitutes a perennial problem.
In most of the countries of the European continent, where a dense swine population is being maintained, swine erysipelas is widely distributed. In many regions it is the one most frequently observed of the acute transmissible diseases of swine. It is less commonly seen in Norway, Sweden, and Britain, although in the last the disorder manifests itself from time to time.

In this country outbreaks of swine erysipelas comparable to the ones observed in Europe did not attract attention until within recent years. It is possible, however, that the malady failed to be recognized or that it may have been confounded with hog cholera. Although regular outbreaks of the disease were not previously reported, indications were not lacking that its causative agent was not absent from the United States.

It was described in various situations by Moore (65), Smith (90, 91), Newsom (69), Tenbroeck (98), Creech (12), Giltner (27), and Ward (102). Its pathogenic tendencies in this country were further manifested by the occasional recognition of the urticarial form of the disorder and by the observation of certain valvular heart lesions of a character quite typical for swine erysipelas.

Beginning with 1931, the acute septicemic form of the disease appeared almost simultaneously in widely distributed areas of the country and engaged the attention of Taylor (97), DeFosset (14), Fosterman (23), Hollenbeck (38), Mohler (63, 64), Munce and Wiley (68), Baker (3), Harrington (30), Hays and Harrington (31, 32), Parker, Lockart, and Ray (72), Stiles and Davis (96) and others.

Precise data pertaining to the incidence and distribution of swine erysipelas in this country are not available, and it is doubtful that they ever will be. That the problem connected with the malady deserves serious consideration was revealed by the results of a survey undertaken by this Station about ten years ago. In connection with this orientation project, 281 outbreaks of acute swine disease were investigated and in not less than 24 per cent of this number swine erysipelas proved to be the malady involved.

Since that time the disease has gained a firm foothold in the principal swine breeding areas of the country. In Nebraska definite erysipelas areas were established and the disease has come to constitute a livestock sanitary problem of the greatest importance.

**ETIOLOGY**

The specific cause of swine erysipelas is the erysipelas bacillus (Erysipelothrix rhusiopathiae), a slender, small rod 1.0 to 1.5 microns in length, as it occurs in the organs of actually affected swine. There they tend to form small conglomerations and as such they are frequently found to be contained in leucocytes. On artificial culture media, long thread-like forms of the organism may be seen; such forms have also been found to be occasionally associated with the more chronic lesions in swine. The erysipelas bacillus is non-motile and it does not form spores.

The microbe grows readily on the common culture media of the laboratory and does so aerobically as well as anaerobically. When inoculated on agar medium, very small, transparent, dewdrop-like colonies appear after 12 to 24 hours at incubator temperature. According to Meyn (61) and Redlich (82),
Swine Erysipelas

The organism growing on agar plates is capable of dissociation in rough and smooth colonies in variable proportions. In two-thirds of the chronic cases examined by Redlich, smooth colonies developed and rough ones in the other third. Smooth colonies only were obtained from the acute cases of the disease. In bouillon cultures the smooth forms caused a diffused cloudiness and the rough ones produce a flocculent growth. Rough colonies in gelatin stab cultures cause a "bottle brush" type of growth, whereas the smooth forms produce a more luxuriant, wide growth along the needle track.

Ordinarily, grown in bouillon the erysipelas bacillus causes slight cloudiness and a slight grayish-white deposit on the bottom of the tube. Inoculated on a gelatin surface, there develop delicate, transparent, bluish-gray colonies which may or may not form short, thin branches. In gelatin stab cultures the typical "bottle-brush" growth is apt to develop within the course of a week. Other stab cultures present spherical, white growths along the needle track. In the older gelatin cultures a slight degree of liquefaction may be observed. The bacillus does not grow well on potato medium.

The swine erysipelas bacillus takes the various anilin stains used in bacteriologic practice. It is most readily shown by the Gram method of staining and this is the one of choice, especially when the organism has to be searched for in tissue sections and smears prepared therefrom. Owing to its smallness and slenderness, it is apt to escape observation when the more simple and direct staining methods are used. With Gram’s method, especially when the material is counterstained with eosin or diluted carbol fuchsin, the bacilli are revealed as tiny, bluish-black rods, amidst or within the pink- or red-colored tissue elements.

Although the swine erysipelas bacillus is not a spore former, it is quite resistant to adverse influences. This quality is commonly attributed to the waxy substance which forms part of its composition. The organisms are capable of retaining their viability and virulence for periods of considerable length in many environmental situations. Dried, while spread on a glass surface and kept at a temperature of 98.6°F., the bacilli have remained alive for at least one month and for a similar period when kept in a dark, cool place. In smears on glass and exposed to direct sunlight they survived for two days. According to Meloni (60) the organisms survived for more than eight years when kept in a refrigerator while they were contained in moldy gelatin. Helm (34) found them still alive and virulent in a broth culture stored for more than one year and Stickdorn (94) even reported a survival period of seventeen years under like circumstances.

Nocard and Leclainche (70) state that the bacilli remained intact in ordinary water for 17 days and in distilled water for twice that period. The reverse was encountered by Stickdorn (94), who found that distilled water had a bactericidal action, whereas the opposite was the case with river and tap water.

The bacilli are sensitive to heat and when kept at a temperature of 111°F. during four days they were destroyed. At temperatures of 104°-112°F. the virus is rapidly attenuated and destroyed in one-half hour at the last-named temperature. At 125°F. the virus is killed in fifteen minutes, at 131°F. in ten minutes, and in a few minutes at temperatures ranging between 131°F. and 137°F., according to Nocard and Leclainche (70). That resistance to heat is
subject to variation is indicated by Von Preisz (101), who states that the organisms sometimes resisted heating at 158° F. for fifteen minutes, although at another time they were killed at 125.6° F. in the same length of time.

In putrid material the erysipelas bacillus is capable of retaining its viability and virulence during periods of considerable length, months even. Von Preisz (101) makes mention of the fact that the organism was still alive in a carcass which had been buried for 280 days and that decomposing erysipelas organs kept at room temperature were still virulent after 7 to 8 months. Opalka (71), on the other hand, could show that although putrid organs may retain virulent organisms for a long time their virulence becomes gradually reduced. However, there is no constancy pertaining to the longevity of the microbe in putrefying substances, since factors other than putrefaction may exercise a potent influence. Meloni (60) observes that the action of putrefaction is determined by the influence of temperature and moisture. Frequent changes in moisture and the lower temperatures are favorable to the survival of the germs, whereas the higher temperatures and absence of moisture tend to shorten life.

Virulence is more rapidly reduced in the presence of a higher temperature and the rate of attenuation is proportional to the height of the temperature.

In the flesh of swine infected with erysipelas, the organisms also display a marked degree of resistance. Their virulence is but slowly destroyed by salting and pickling. In strong brine, even, the virulence of pure cultures disappeared only after 26 days. Salting hams with common salt and saltpeter has failed to destroy virulence after thirty days' exposure, and the pickling fluid was still virulent after 170 days. Well-smoked hams were still virulent three months later, but after six months the bacilli were found to be destroyed (Nocard and Leclainche, 70). According to Glässer (28), the intensive smoking for two weeks after pickling of pieces of not more than five pounds in weight killed the bacilli. Pieces of infected meat six inches thick required two and one-half hours of cooking before the heat had sufficiently penetrated to bring about complete sterilization. Roasting for such a length of time does not always kill the germs (Von Preisz, 101).

The swine erysipelas virus is vulnerable to most of the disinfectants used in sanitary practice. It is destroyed by four hours' exposure to formaldehyde vapor, and in contact with solutions of phenol or the saponified cresols it succumbs in about 15 minutes. Hypochlorite of lime (1.0 per cent), mercuric chloride (0.1 per cent), copper sulphate (0.25 per cent), and hot solutions of lye (1.0 per cent) destroy the bacilli with varying degrees of speed in accordance with the nature of the medium in which they may be contained.

In the European countries where swine erysipelas is a common disorder and probably on the farms of this country, where it prevails as well, the causative organism is more or less ubiquitous in the areas involved. In such environments it exists in the soil as a saprophyte and it may be found wherever nitrogenous substances are decomposing. Evidence has been presented that the bacillus in such situations not only can maintain is viability but may actually multiply there when conditions are favorable for its development. Von Preisz (101) mentions that in sterile earth mixed with alkaline liquid stable waste or hay infusion the germs will vigorously multiply at a temperature of 98.5° F. and grow throughout a layer four inches in thickness in from ten to thirteen
days without loss of virulence. Hesse (35) could show that the viability of swine erysipelas bacilli in various types of soil is subject to considerable variation. Sandy soils rich in lime and humus are especially favorable to the organisms.

In ground with an alkaline reaction the vitality of the bacilli had not been reduced after a sojourn of 90 days and, to the author cited, it appeared not impossible that vitality might be maintained for years. Naturally acid soils, with the exception of sour sandy ones, as well as the ones artificially acidified, destroyed the bacilli within the first few days after their introduction. Variations in the nature and reaction of soils apparently contribute a factor in the epizootiology of the disease. Maurice Vallée, cited by Forgeot (22), has pointed out that erysipelas is a disorder peculiar to certain regions and that particularly in those, the soil contained the germs concerned, and that earth obtained from regions where the disease was unknown did not lend itself to the cultivation of the organism. Not only has the organism been found in soil but also in a variety of other substances. Hettche and Danneel (36) demonstrated its presence in city sewage.

In swine affected with the acute septicemic form of the disease the bacillus can be readily found in the various organs of the body. The number of organisms found in the blood and the other tissues may differ considerably. Spleen, kidneys, lymphnodes, bone marrow, and heart blood of actually affected animals, as a rule, contain the germs in considerable numbers. In the circulating blood they cannot always be readily demonstrated. In blood smears they may be found in the leucocytes, either singly or as distinct conglomerations. In the more chronic or benign forms of the malady, such as in valvular endocarditis, arthritis, or “diamond skin disease,” the bacilli are to be found in the lesions.

Pitt (77) found that in swine which had recovered from either light or severe forms of the disorder, the bacilli could be demonstrated in the gall bladder, that they may remain there for long periods, and that their viability and virulence were not impaired. The presence of erysipelas bacilli in healthy swine has special importance in livestock sanitation. In countries in which the disease is frequently observed such cases appear to be far from uncommon. Bauermeister (6) relates that the bacterioscopic examination of the tonsillar secretions of 140 swine revealed that pathogenic bacteria, namely, the swine erysipelas bacilli, were constantly present. Pitt (76) found by examination of intestines of 66 healthy hogs that the organisms concerned were in 26 and by an examination of 50 swine they were found in the tonsils of 28 animals. Manninger (58) makes mention of similar observations and in addition calls attention to the presence of the bacilli in the mucous plugs within the crypts of the ileocecal valve.

The swine erysipelas bacillus has also been found in a considerable assortment of animal species other than swine, either as harmless parasites or the cause of disease. Reports are available pertaining to their presence in man, cattle, dog, duck, fowl, turkey, pigeon, mud hen, parrot, and the birds of a zoological garden. Poels (78) suggests that swine may become infected by devouring small animals which harbor the micro-organism.

The swine erysipelas bacillus, although by no means constant in its virulence, is capable of displaying pathogenic qualities in a considerable num-
ber of animal species in accordance with their specific or temporary susceptibility. Pigeons and white mice most readily succumb to artificial infection and hence they are the laboratory animals of choice in bacteriologic studies of the malady. Pigeons sicken with an almost certain degree of constancy after the intramuscular injection of 0.005 cc. of a broth culture of the organism or with small quantities of a suspension of spleen or kidney tissue derived from hogs actually sick with the disease.

The rabbit is quite resistant and when inoculated under the skin of the ear it is apt to respond only by a localized erythema near the site of inoculation. That this resistance may be only a relative one was suggested by the results obtained by Jean (45), who found that when rabbits were subcutaneously injected with small doses of culture and at the same time their articulations were subjected to trauma, this procedure brought about joint affections with which the erysipelas bacilli were etiologically associated.

The guinea pig also appears to be resistant to the swine erysipelas microbe. That there may be exceptions to this general rule is indicated by Balozet (4), who reported the finding of the bacillus in spontaneously affected cavias. Meloni (60) could recognize a considerable degree of susceptibility in common sparrows, field sparrows, canary birds, finches, siskins, thrushes, blackbirds, turtle doves, and quails. He further found that although old geese, ducks, and common fowls could not be infected with swine erysipelas, this succeeded when young birds were selected.

Most species of farm animals display an imperfect specific resistance to the disorder, but apparently certain unknown influences and factors may bring about invasion by the organism with, now and then, actual disease as the result.

A considerable number of investigators submitted evidence of the difficulty encountered in attempts to infect swine at will. Basset (5), Böhme (9), Creech (13), Francke and Goertler (24), and others recognize the influence of unknown contributory factors as playing a part in the etiology of swine erysipelas. In the experience of the present writers, attempts to transmit the disease to swine by the feeding of or the inoculation with virulent material failed to reproduce the disorder in a form comparable with the one observed in the field. At best only a transitory rise of temperature could be observed in these cases.

That the disease in a classical form has been artificially induced cannot be doubted but apparently this cannot be done with the constancy observed in the case of other diseases of microbial origin.

It has been observed that the bacillus of swine erysipelas may display a capacity to change suddenly from a harmless saprophyte to a decidedly pathogenic parasite. Whether such a phenomenon can be attributed to conditions which exalt the virulence of the microbes *per se*, or to influences affecting susceptibility of the animals concerned, or to some reciprocal action between these two possible factors remains entirely in the dark. Either one of them, however, may serve to explain the sudden increase in the incidence of swine erysipelas in the course of certain years in areas where the malady occurs enzootically.

That the virulence of the erysipelas microbe is subject to *variation and that* this may be demonstrated artificially has been revealed by many observations.
Stickdorn (93) observed that by continued culture passages the virulence becomes gradually reduced though not in an ever progressive manner. Such passages may terminate in its complete loss for such highly susceptible animals as white mice.

As had already been demonstrated by Pasteur and Thuillier (73, 74), the modification of the virulence of the swine erysipelas bacillus is possible by various processes. The virulence is exalted by serial passages through pigeons in such a manner that with a constant dose of culture the animals die after progressively shorter periods of incubation. With a similar treatment of rabbits the organism becomes more virulent for this species, but becomes gradually less so for swine and then is only capable of bringing about the slightest disturbance in such animals.

There is agreement among investigators that in natural infection, the organisms are eliminated when contained in the body wastes of animals involved in the infection, and that those present in the environment (soil, water, manure, etc.) enter the body of swine in a state of susceptibility through the mouth and that they enter the blood stream through the intestines and, without doubt, also through the tonsils. That the infection may also come about through wounds and abrasions of the skin is quite obvious. The bacilli apparently possess, a marked capacity for entering the general circulation and for rapidly multiplying there, as well as in the organs of the body.

**EPIZOOTIOLOGY**

Swine erysipelas is widely distributed in many countries of the European continent where for many years it has continued to present a perennial problem. This appears to be particularly the case in the centrally located states, where a rather dense swine population is being maintained. Although none of the European countries is exempt from the malady, perhaps the least involved are the northern areas, including the Scandinavian peninsula. Great Britain has also been reputed to enjoy comparative freedom from the disease, although it seems possible that such a favorable situation may be more apparent than real. An official statement (8) of 1910 makes mention of the fact that the records of field investigations pertained to not less than 1,200 outbreaks annually. They showed that at least one pig died in each outbreak and that this number could not be taken as representing the annual outbreaks of swine erysipelas, because in most cases the disease assumed a mild form.

As far back as 1892 (16) it was stated that there was strong reason to believe that outbreaks could not be rare in Britain. The apparent mild character of the disorder as compared with its more marked malignancy on the continent may account for the fact that many writers mention a relative freedom from erysipelas in that country.

It is quite probable that in any country or region maintaining a more or less dense hog population, the disease may either actually be encountered or eventually be introduced. Until more recent years the United States also enjoyed a favorable reputation in regard to swine erysipelas. Then, outbreaks comparable to those of the acute, fatal form seen elsewhere, began to be observed. That the etiologic factor and the milder or chronic forms of the infection were observed in this country in the course of several decades has already been mentioned. Hence, it is not impossible that even fatal outbreaks
may have occurred without being identified as such. The marked incidence of hog cholera, combined with the manifest difficulties encountered in the differential clinical diagnosis of the two diseases, may readily have caused swine erysipelas to escape prompt recognition in occasional outbreaks.

The epizootiological behavior of swine erysipelas is by no means a constant one, as may be surmised from the several factors which may exercise an influence in etiology. On the whole the malady is inclined to occur enzootically, although there is an abundance of evidence of its capacity to assume the allures of a true epizootic. In the course of certain years the disease is apt to show a markedly high morbidity rate and during others it may be relatively low. A certain rhythm of the incidence may be observed. Francke and Goertler (24), observing the disease in Germany, where it is commonly prevalent, indicate a maximum morbidity after periods of three to five years with a relatively low incidence between. They are inclined to attribute this phenomenon to the elimination of the more susceptible swine during the period of high morbidity.

The mortality rate in more or less constantly affected countries may also show a marked degree of variation. Even in districts not far removed from one another, the death rate from swine erysipelas may differ greatly. In some areas the disease may be mild, at least as expressed by mortality, whereas in others, simultaneously involved, the losses may be extremely severe. Peterman (75) has observed that outbreaks on Nebraska farms nearly always begin with a sudden onset. Some animals may unexpectedly be found dead and occasionally he has encountered outbreaks in which individual animals would succumb at intervals of a few days, the deaths persisting for a month or longer. As a general rule, however, herds became rapidly involved after the first deaths had taken place. Hays and Harrington (32), making their observations in South Dakota, report that a number of pigs which displayed chronic manifestations of the disorder were segregated on a farm where erysipelas had not previously occurred. Later on these animals were turned into the common hog lot, after which the original inhabitants then promptly sickened with acute erysipelas. In such cases direct transmission remains as a manifest possibility although in established erysipelas territory such a conclusion may be open to challenge.

Francke and Goertler (24) do not regard swine erysipelas as a disease which rapidly spreads over extensive areas, but speak of its extension as being locally limited and confined to certain districts. This opinion is apparently shared by Nocard and Leclainche (70), who observed that where there is diffusion from permanent infection zones into secondary zones (not infrequent), in the majority of cases the malady does not tend to persist. Occasionally a serious epizootic breaks out and may in a creeping manner extend beyond the original focus. It is, however, relatively uncommon that the disease maintains itself permanently in a newly invaded territory previously exempt from the infection. Only now and then does the disease obtain a firm foothold in a previously disease-free area or acclimate itself there from the first so as to establish a new center of the malady.

That swine erysipelas in farm outbreaks may also present peculiarities difficult to account for, is shown by Harrington (30). On one farm 200 recently purchased pigs were introduced; they belonged to two different and
distinct breeds. The pigs representing one of these breeds developed swine erysipelas to a more or less marked extent and the ones belonging to the other breed remained exempt from the infection. In accordance with the author's opinion, there is no reason to believe that differences in breed susceptibility could account for this phenomenon. However, as the antecedents of these swine were apparently not accounted for, the possibility of the resistant lot having previously acquired immunity cannot be altogether dismissed. The same author also comments on the variations of the morbidity rate in different outbreaks. Sometimes only a small number and in other outbreaks all swine of a given herd may become involved.

The spread of swine erysipelas, its transmission from place to place, is subject to a number of contributory factors, among which the geographic position of the areas concerned, the density of the swine population, commerce and traffic in hogs, and the type of soil may have a place.

That direct-contact infection may play a part must, for apparently good reasons, be admitted, although Francke and Goertler (24) expressed the opinion that this may come about only in an insignificant part of the cases. That acutely or chronically affected animals may serve as the vehicles of infection in its spread from place to place is generally recognized. However, in districts where erysipelas exists enzootically, observations indicating that such a transmission had taken place should not, as a rule, be accepted without considerable reservation. The same prudent attitude is warranted in the instances in which cultures of the bacilli used in simultaneous immunization are held responsible for the treated animals becoming virus carriers and spreaders. This manner of spread cannot altogether be deemed to be impossible, yet it is very difficult to find concrete evidence on this question which cannot be successfully challenged.

Such infection vehicles as stable manure, body wastes, and slaughter offal cannot always be implicated in manifest erysipelas territory. On the other hand such a means of transmission may be accepted as actual in instances where swine in remote, previously disease-free areas, sicken with erysipelas after the feeding of materials derived from infected animals. On this point there is a sufficient volume of positive evidence which cannot be questioned.

Transmission of the disease by means of contaminated water courses must also be recognized as a possibility but, as in similar situations, there are no clear-cut indications that it is more than of exceptional occurrence. Dissemination of the infection by animals other than swine, and by persons, has always been suspected of playing a part. But, as in the case of hog cholera, the evidence usually is merely circumstantial. Stiles and Davis (96) state that flying birds may be suspected of being the possible vehicles for the bacilli and that there is some evidence that moles, rats, mice, and other rodents have been implicated in the spread of swine erysipelas. A similar possibility was also suggested by Poels (78) many years ago.

Infected soil, no doubt, may serve as an infection reservoir, but its function as a vehicle for the virus is probably not a very prominent one. It may, however, do so in certain instances. Such a one is suggested by a British writer (1) who was led to suspect that the prevalence of swine erysipelas in certain areas probably followed potato growing and feeding, and that the swill tub is a frequent source of infection, owing to the swill becoming contaminated by potatoes carrying infected soil.
The incidence of swine erysipelas is subject to the influence of season (Fig. 1). It is highest during the third quarter of the year and lowest during the first one. In the course of the second quarter, cases and outbreaks become more numerous and they decline in the last quarter. Whether or not this phenomenon can be entirely explained by taking into account prevailing temperatures alone, is not certain. It is quite possible that other factors not yet fully appreciated may also have an influence.

![Seasonal Incidence of Swine Erysipelas](image)

**Fig. 1.**—The seasonal incidence of swine erysipelas.

It is a common belief that the susceptibility to swine erysipelas is the least marked in pigs belonging in the age group under three months and that morbidity is greatest among swine within the age group of from three to twelve months. However, there is evidence to show that older swine exposed to the infection are apt to contract the disease. With regard to the liability of pigs of tender age to become involved in the malady this is by no means to be disregarded. Nebraska observations most certainly indicate that on infected farms such animals are not always exempt and the disease has even been recognized in pigs less than one week old. Although Fröhner and Zwick (25) make mention of the fact that pigs nursed by brood sows affected by erysipelas
as a rule escape disaster, it would be somewhat hazardous to withhold prophylactic measures from such animals.

Certain influences have been credited with playing a part in the occurrence and dissemination of swine erysipelas, although it cannot be said that opinions on the subject are all based upon actually controlled observations. That certain soils are more suitable than others for the retention of the erysipelas bacillus in a viable and virulent state has already been mentioned, but there are no scientifically established data showing that their geologic character can be held accountable for the phenomenon. Harrington (30), observing the disease in South Dakota, found it without any marked preference for certain soils, although the more severe outbreaks were witnessed within areas of the heavier gumbo clay soils.

Earlier writers were inclined to believe that the more improved and refined breeds of swine showed a greater liability to contract swine erysipelas than the common strains. At the present, this feature is less emphasized than formerly. Harrington (30) does not believe that breed differences need to be considered with reference to susceptibility and reports that he found the malady among all the various breeds of swine.

That environments, faulty from a hygienic point of view, as well as inadequate feeding practices, may have their influence can be accepted on general principles. Likewise must it be recognized that the previously sustained disorders, common among the younger swine, may leave them with a reduced capacity for resistance and hence more liable to the infection, when, at a later age, they are exposed to swine erysipelas.

The vagaries in the epizootiological behavior of swine erysipelas have engaged the attention of observers ever since the disease could be accurately identified. Many explanations have been offered or attempted without throwing light on the subject. Nor has it, thus far, been possible to approach the problem by any method of inquiry of a promising nature. Since the days when Nocard and Leclainche (70) wrote, "... at the present state of our knowledge it is impossible to explain the mysterious behavior of the contagion," little or nothing has been contributed to bring clarity into the matter.

Hence, it remains impossible to account for the sudden appearance and frequent outbreaks of the malady in this country, where only during the last few years it has presented itself in a form comparable to the one which, on the continent of Europe, gave the disease such a formidable aspect. Evidence has been presented to show that it had existed here more or less sporadically in its less malignant forms. What caused it to appear in its more damaging character, and with such apparent suddenness, escapes observation altogether.

The epizootiologic phenomena presented by the disease show, furthermore, a conspicuous contrast with the results obtained in animal experiments. The severity of outbreaks, compared with the difficulty of artificially inducing the disease in swine, indicates that the virus per se is not the only factor to be considered.

In erysipelas territory, the specific etiologic factor is a frequent inhabitant of the soil and even of the organs of swine in perfect health. In these situations they seem to be relatively harmless, yet capable of having, in some manner, their virulence exalted. Francke and Goertler (24), familiar with the swine erysipelas situation in Germany, state that 25 per cent of all swine may
be regarded as virus carriers. Apparently such animals do not constitute a very serious menace to their companions, and in infected districts where the bacilli linger in the soil the disease may not assume an epizootic form.

It has been stated that the disorder declares itself only when an exalted virulence of its microbic cause is synchronous with a lowered resistance of swine. The thought has been expressed that this may come about under the influence of the increased temperature of the warmer season, when morbidity is always higher. Such an explanation may be tentatively accepted for lack of a better one. However, there is ground for the belief that a more complex process is involved. Nor is it impossible that the bacilli, in order to become fully virulent, must make several passages from swine to swine, with or without causing manifest disease, and that only when virulence has reached a maximum can it become possible for the malady to be transmitted from animal to animal by direct or indirect contact.

Francke and Goertler (24) also call attention to the fact that the incidence of swine erysipelas begins to rise with the first quarter of the year and that throughout a sequence of several years the morbidity level during the first quarters shows approximately the same height. They convey the impression that the exaltation of the microbic virulence may be an annual process. They classify swine erysipelas as a "Reizseuche" (provocation disease) to express the idea that the etiology is not only dependent on the intake of the bacilli, but even more so on the variability of the susceptibility of the animals concerned. These authors even suggest that the mere transmission of the specific microbes may be of secondary importance.

**CLINICAL MANIFESTATIONS**

The clinical manifestations of swine erysipelas vary within a rather wide range and appear to be determined by the virulence of the causative microbes, their mode of invasion, and the state of the susceptibility of the swine exposed.

It is, however, possible to recognize certain clinical forms which, owing to their distinct character or course, permit a separate description. We are thus enabled to speak of acute and chronic types of the disease. The former are represented by the common septicemic form of the malady and by the more benign urticarial or cutaneous manifestation of the infection. The chronic forms, which may be no more than the remote sequels of the acute infection earlier sustained, express themselves as valvular endocarditis and arthritis.

The very nature of swine erysipelas is warrant for the occurrence of cases which are difficult to assign to the more precisely defined groups. In addition, one must also expect to encounter more or less sporadic cases in which the results of earlier infection, complicated or not by secondary infections, produce a malaise or cachectic state arising from parenchymatous damage which cannot readily be recognized by ordinary clinical methods.

The acute septicemic form of swine erysipelas is the one most commonly observed and is responsible for the major part of the losses caused by the disease. The symptoms manifest themselves after incubation periods somewhat varying in length. After natural or artificial infection the exposed animals usually display an incubation of three to five days, although the periods observed may show a wider range. The variation can be attributed to the volume
of virus taken in, to its degree of virulence, and, without doubt, also to the momentary susceptibility of the infected swine.

After the feeding of swine with such highly virulent materials as the organs or slaughter offal of infected animals the disease may, if it develops at all, declare itself in one or two days, whereas in other cases incubation periods of as long as eight days have been recorded. It is obvious that certain depressing influences to which swine may have been exposed at the time the bacilli were introduced, also tend to shorten the length of incubation.

The septicemic form of swine erysipelas generally reveals itself first by ill-defined manifestations of a general nature, such as somnolence, capricious appetite, etc. The animals concerned are less lively, show languor, and are inclined to remain recumbent in the litter. A marked rise of the body temperature is one of the earliest symptoms, the body heat ranging between 105° and 110° F. The fever persists throughout the course of the illness and only declines with approaching death or with the beginning of recovery. The onset of the sickness is nearly always sudden and it is not uncommon to find several animals simultaneously involved.

The sick swine no longer take interest in what happens around them and prefer to remain hidden in their bedding. The appetite is badly impaired and even during the earliest phases of the malady may be completely lost. A moderate desire for cool water may, however, have been retained.

If aroused and forced to move they manifest weakness of the hind quarters and wobble when they walk.

In certain cases in which the animals have not become entirely helpless they show a peculiar stilted and stiff gait. When such animals are handled they may squeal with pain. There is shortness of breath and the voice is hoarse and husky. At first, bowel movements are retarded and the hard feces are covered with mucus and in certain animals may be streaked with blood. As the disease advances diarrhea may be observed in the course of which pasty or watery stools of a light gray color are discharged; the occasionally seen brown or brownish feces indicate the presence of blood.

It is by no means uncommon for some of the affected swine to show nausea and vomiting. The conjunctiva is usually injected, the eyelids swollen, and an accumulation of thick mucus may be seen in the corners of the eyes. The rate of respiration becomes more hurried and a more or less suppressed cough is sometimes heard. The frequency of the heart-beat is increased and the pulse is rapid and intermittent. Some of the animals may show evidence of chills. The symptoms rapidly gain in severity and with the development of pulmonary edema, a not uncommon complication, there is respiratory distress and the visible mucosae become cyanotic.

On or about the second or third day of sickness and, in exceptional cases, earlier, or even not until death is impending, there develop on the less haired, softer areas of the skin, red patches of irregular type and form. They manifest themselves particularly on the ears, the snout, the axillae, the lower surfaces of the thorax and abdomen, the inner surfaces of the thighs, the groin, and the perineal region.

These patches are neither tender to the touch nor swollen and only distinguish themselves by their color. In the beginning the latter is light red or pink, but later the tint is apt to deepen to red, dark red, and even violet or
purple. The color yields to finger pressure but upon its release it immediately reappears. The erythematous areas are not sharply defined. They tend to enlarge and to become confluent until the greater part of the body surface may become involved. In other cases the red areas may remain more or less localized. In the peracute cases of swine erysipelas, the redness of the skin may not appear at all or its appearance may be delayed until the agonal period or even to the one immediately following death.

In a few cases very small vesicles have been observed to form on the reddened surfaces. They contain a serous fluid which eventually dries as a brownish incrustation. The presence of punctiform or larger petechiae and local necrotic processes in the skin have also been noted as complications or possible sequelae of the erythema of swine erysipelas. Hutyra and Marek (39) mention cases in which at some part of the body a red spot develops with a dark brown center. It is suggested that those areas may indicate inoculation sites, as only after their appearance do the general symptoms of swine erysipelas develop.

The reddened skin and its mode of development are, by most authors, recognized as one of the most characteristic symptoms of the disease. It is, therefore, noteworthy that the condition is scarcely ever mentioned by American observers. It is possible that the disease in this country, at least to that extent, differs from the one seen in Europe, while, on the other hand, the discoloration may have escaped observation here because of the prevalence of black or otherwise pigmented breeds of swine. Lydtin and Schottelius (57) and Moussu (66) also called attention to the fact that in colored animals the discoloration of the skin may not be so readily recognized.

As a general rule, the disease runs a rapid course. Deaths within 24 hours after the first symptoms are not uncommonly observed in the peracute cases. In the ones of slower course the sickness lasts two to three days and most deaths occur on the third or fourth day. That animals may linger from eight to ten days before death overtakes them has also been recorded.

It is generally believed that animals which have survived the fourth day of illness have a chance of recovery, which improves with every succeeding day. Recovery begins with the return of the appetite and normal alertness and with a simultaneous drop in the body temperature. At the same time the erythema begins to fade. However, recovery may be only apparent and after a period of good health evidence of chronic erysipelas may come to light.

Death is ushered in by increasing respiratory distress arising from pulmonary edema and cardiac weakness. The temperature drops and the cyanosis of the mucosae becomes more pronounced and even the skin may acquire a more or less livid color.

The prognosis in cases of this form of swine erysipelas must always be unfavorable, unless very early serum treatment is possible. The case mortality rate ranges between 50 and 100 per cent, with 75 per cent as a probable average.

The urticarial form or "diamond skin disease" (Fig. 2) constitutes a more benign manifestation of the disorder. According to Nocard and Leclainche (70) it is more frequently seen in the young than in the older swine. Like the more common or septicemic form of the malady, the cutaneous disease is also initiated by vague systemic disturbances. As a rule, the symptoms are of a milder character and occasionally so slight that they escape the observer's attention. Commonly there is a rise of temperature (104°–108° F.). The
appetite fails and the animals are inclined to seek a cool place to conceal themselves. Defecation is retarded and affected swine show stiffness and evidence of pain when moving about. Occasionally an animal may exhibit marked muscular weakness and inability to maintain itself standing.

This general indisposition rapidly improves after the appearance of the characteristic skin eruption. This is primarily of an entirely different nature from the erythema of the septicemic type of the disease. It manifests itself by the appearance of light red or pinkish patches of the integument of the chest, belly, loins, shoulders, the external surfaces of the thighs and not infrequently of other areas of the body surface.

The number of these patches or wheals varies. Sometimes only a few are present and then again a case may be observed in which the whole body surface is thickly beset by them. The wheals are slightly raised above the level of the surrounding skin. They are sharply outlined and may be surrounded by a red or pink zone. Their more common form is that of a rectangle, quadrangle, or rhombus, although sometimes they are more rounded in outline. They vary in size, but more frequently they range from three-fourths of an inch to 1¼ inches. Larger ones may also be observed. When close together they tend to become confluent and may then give rise to patches of considerable area.

The light tint of the wheals gradually deepens to a red, dark red, or reddish brown color, which in time begins to fade. This fading begins in the center of the patch and from there the disappearance of the dark color progresses toward the margin until the normal skin color has been restored. Unless interrupted by certain complications the evolution of this form of swine erysipelas is usually completed within 8 to 14 days, with recovery as the result.

However, complications may have to be reckoned with. Cases have been observed in which the wheals become studded with small vesicles, filled with a clear serous fluid. These finally dry up and then form brownish or reddish crusts or scabs which may endure for some time before they are cast off. Likewise it is possible that the wheals may become gangrenous and especially so in the cases in which they have become confluent over considerable areas. In such cases the necrotic process may result in large patches of dead skin, occasionally covering the entire back with a hard, leathery shield. Unless the animal succumbs to intercurrent sepsis, or other complications, the dead parts are eventually sequestrated and the resulting skin damage repaired by the formation of a dense, hard, even cartilage-like cicatrix. Such parts as the ears or the tail may be lost in the course of this process. The dry gangrene of the skin is a comparatively rare sequel of the infection and may also be observed after apparent recovery from the acute, septicemic form of the disorder.

Occasionally the urticarial type of swine erysipelas, either before or after an apparent recovery, results in the development of an acute septicemia caused by the specific microbe. Such cases nearly always have a lethal termination. The case mortality of “diamond skin disease” has been estimated at two per cent and without doubt most of these deaths can be attributed to some of the complications mentioned.

The fact that apparent recovery may be followed by some of the chronic manifestations of the disease should also be taken into account.

Joint involvement is a common sequel to swine erysipelas infection. It may
Fig. 2.—“Diamond skin disease.” (By courtesy of Dr. J. R. Mohler, Chief, Bureau of Animal Industry.)
occur as an independent manifestation or it may follow in the wake of acute disease or as an accompaniment of other chronic forms.

At a given time one may notice that some of the joints of exposed animals are enlarged and that the swollen parts are hot and painful. The hips, tarsal, carpal, and phalangeal joints are the ones most frequently affected. However, no joint appears to be exempt and Harrington (30) observed that sometimes all joints, even those of the caudal vertebrae, were enlarged.

After their first appearance, the symptoms of acute articular inflammation tend to subside and the lesions assume a chronic character. Periarthritis and periostitis leading to bony enlargements and thickening of the soft parts may produce deformity and distortion of the limbs. In most cases locomotion is considerably hampered; the animals become stiff and show a stilty gait and prefer to lie down a good part of the time. The desire for food declines and the swine become unthrifty.

Articular infection, however, is not always characterized by distinct swellings and enlargements. It may only be expressed by stiffness and pain when the affected animal is forcibly moved, as well as by the assumption of a posture in which only the tips of the toes rest upon the ground. Such animals usually remain backward in growth and development. As in the other clinical forms of swine erysipelas, the affected animals tend to develop weakness and paresis of the posterior extremities.

Endocardial involvement is most frequently observed in animals which have apparently recovered from the acute types of swine erysipelas. Such subjects may, for a period of several weeks, show the ordinary signs of good health and then begin to appear listless and fatigued, while the appetite loses its usual keenness. They no longer rush to the trough at feeding time, but prefer to remain recumbent. Their posture in recumbency is frequently quite characteristic. Instead of lying flatly on their sides the hogs affected with endocarditis are inclined to rest on the sternum and elbows or to sit on their haunches, dog-fashion.

The animals commonly develop a slight cough and sooner or later shortness of breath will be observed. The respiratory frequency is increased and the breathing is shallow. In the more advanced cases there is distinct dyspnea. In animals kept quietly in the stable these symptoms may not always be manifest; but when they are forced to move about, a degree of respiratory distress soon declares itself.

The heart action is labored; there is cardiac palpitation; and the impact of the heart against the chest wall may be clearly felt or seen. The heart action is of a throbbing, pounding nature and the cardiac sounds have lost their clearness. In systole and sometimes also in diastole, rough, blowing bruits may be heard. The pulse is rapid and often thready in character.

As a result of cardiac and respiratory deficiency, the visible mucous membranes become cyanotic and red, or livid patches appear on the skin, especially about the ears and the neck. Edema of the extremities may likewise be observed. Paresis of the hind quarters, as a result of aortic stenosis, is not a rare symptom.

These more characteristic symptoms are nearly always accompanied by fever (103°–106° F.), and diarrhea is frequently noted. From the very be-
gaining the hogs involved lose weight and towards the end may present a crusty eczema.

While the phenomena described above are the ones most commonly observed, a variability in clinical manifestations must be given recognition. Light cases may be encountered in which cardiac compensation renders the lesions present compatible with life and a certain degree of thrift. On the other hand, a certain number of animals are apt to succumb suddenly without any previous signs of illness.

On the whole, recoveries are rare and the prognosis must always remain very unfavorable. In the majority of the cases death occurs within two weeks after the first symptoms make their appearance. The lethal termination is induced by cardiac failure and its more remote sequela.

**PATHOLOGIC ANATOMY**

The autopsy of swine which have succumbed to the acute form of swine erysipelas reveals lesions such as may be observed in cases of any septicemia due to other microbic causes. With the exception of the skin lesions of the urticarial form of the malady and the ones associated with chronic endocarditis, there are no anatomic changes of a strictly pathognomonic character.

Careful post mortem examinations may, however, be helpful in obtaining an adequate understanding of the disorder and will frequently be an aid in diagnosis when diseases with a more explicit lesion complex have to be excluded. Attention is therefore called to the changes of a pathologic nature which may be encountered in swine erysipelas.

In the swine erysipelas carcass, rigor mortis is commonly incomplete and of short duration. The entire cadaver may present a dark red or purple color. Upon incision the vessels of the subcutis are usually engorged with blood and the subcutaneous connective and adipose tissues are apt to present a pale pink color.

The blood shows no changes which can be attributed to erysipelas per se. As a rule it contains scant numbers of bacilli, the greater part of which are engulfed by the leucocytes. The capillaries of the peripheral circulation may show bacillary emboli. In accordance with the circulatory and respiratory disturbances, which preceded death, the blood is rather dark in color when it is removed from vessels. The clotting is commonly incomplete. After contact with air the brighter red color returns and coagulation is completed.

The nature of the cutaneous changes which may be observed in swine erysipelas have already been described in connection with the clinical manifestation of the disease. After death the discoloration may take on a darker hue. The removal of the skin may reveal that the fatty tissues are somewhat softened, while the cutaneous discoloration may have extended into the subcutaneous fat to some depth.

The erythema peculiar to the disease is brought about by damage to the capillaries due to bacterial action. Histopathologic changes are seen in the papillae and the subpapillary and upper layers of the derma. The papillae are enlarged and present marked hyperemia, the vessels being distended with blood. The latter is apt to contain a variable number of bacilli. Occasionally small hemorrhages are observed in the connective tissue elements of the
papillae. The lymph vessels and interstices show round-cell infiltration, and here and there local necrotic areas arising from circulatory stasis may be observed.

In the urticarial form of the disease the wheals show inflammatory edema of the skin, the vessels of which are dilated and sometimes contain thrombi. Capillary hemorrhages may be encountered in the papillary layer and bacilli may be present in the tissue interstices. The nature of the erythema of the septicemic form of the disease and of the “diamond skin disease” is fundamentally the same. The two conditions differ only in degree and distribution.

The skeletal muscles and the myocardium of animals dead after an attack of acute septicemic erysipelas may be either quite normal in appearance or present evidence of certain degenerative changes. In the latter case they have usually lost their normal color, lustre, and consistency. The tissue is softer than that of normal muscle and is more brittle and friable. The muscles thus affected may be distinguished from those of healthy animals by a pale red or grayish color. Occasionally hemorrhages are observed, while the intermuscular connective tissues may be moderately edematous.

The myocardium does not always appear to be damaged, although evidence of degeneration, cloudy swelling, is not uncommonly observed. In such cases the muscle tissue is pale and somewhat softened. In addition the heart muscle may present well-defined red areas. Ecchymoses in and under the endocardium, especially near the origin of the large vessels, may be observed with considerable frequency.

The lesions of the lymphnodes of animals dead with the disease are variously described and the findings of pathologists are not always in agreement. Whereas some continental observers mention a dark red or even a reddish black discoloration, others state that such changes were not seen by them and that actual hemorrhages within the nodes scarcely ever came to their attention.

Such differences may be accounted for by the fact that the various descriptions may not always pertain to the identical anatomic position of the lymphnodes observed. They may arise because the regional nodes receiving the lymph drain of an organ primarily involved may present an aspect quite different from those of some other part of the body.

As a rule the lymphnodes are edematous and more or less congested. The degree of hyperemia may differ; in some cases there is but a slight redness, whereas in others there may be an intensely red color. Thus the mesenteric lymphnodes regional to an inflamed section of intestine may show a marked hyperemia or even a hemorrhagic infiltration while the body lymphnodes of the same cadaver may present only a moderate degree of edema or even nothing at all of pathologic import.

In the acute form of the disease the nodes are commonly somewhat enlarged, hyperplastic, and the cut surfaces reveal an excess of moisture. Small hemorrhagic foci may be seen in their cortices. As a rule the altered condition may be accepted as being due to specific infection of lymphogenic origin. Parts of the body without direct communication with an intensely invaded organ may show only trivial changes or even have a normal appearance.

The bone marrow in acute cases of swine erysipelas has been found to be of an abnormally red color, soft, and friable of texture.
In acute swine erysipelas the spleen is commonly moderately enlarged, even if this phenomenon is by no means a constant one. In the more acute or peracute cases the organ is hyperplastic, whereas in the less virulent forms of the disease the enlargement may be very slight. In the latter case the normal color of the spleen may have been retained. In the case of the more manifestly enlarged spleens, the color is red or brownish red and the organ feels tense and resistant to the palpating finger. When pressure applied to the organ is increased the pulp under the capsule may be crushed.

Upon section the pulp is apt to well up from the cut surface, but it is not liquefied to a degree to cause it to leave the intertrabecular spaces. As a rule the pulp has softened and when there are marked hemorrhagic changes, it may assume the appearance of a mushy mass, comparable to a dark grape or plum jam. In animals dead with the septicemic erysipelas, the spleen pulp nearly always contains the causative microbes (Fig. 3) in abundance.

Occasionally spleens may be encountered in which the swelling is not evenly distributed over the entire organ. In such cases there may be localized areas of hyperplasia and congestion which cause the organ involved to present a knobby appearance.

Infarcts may be observed in the spleens of swine which have succumbed to valvular endocarditis. As the latter is of rather uncommon occurrence in comparison with the more acute forms of the malady, splenic infarcts are but rarely seen. When present, they come about by vascular occlusion of embolic particles detached from the cardiac thrombus.

Changes of the large serous membranes are not conspicuous in swine erysipelas. Commonly there is a small amount of transudate in the cavities concerned which may either be colorless or yellowish, or it may present a pinkish tint. Suspended in the fluid, there may be small fibrinous coagula or pieces in the form of flakes or slender threads. Pseudomembranous formations loosely adhering to the serosa of the pleural, pericardial, or peritoneal sacs may be observed. Ecchymoses or petechiae are occasionally observed. A serofibrinous pericarditis sometimes is an accompaniment of the endocarditis of swine erysipelas. After death from the acute malady subepicardial ecchymoses may be observed on the cardiac auricles.

The lungs, after death from acute swine erysipelas, are commonly found to be edematous and congested. The bronchi may contain a pinkish froth and the marginal portions of the pulmonary lobes may show atelectasis. The pulmonary edema and the bronchial froth may be of recent origin, having come about during the death struggle. Small hemorrhages have been observed now and then, but pneumonia cannot readily be associated with the disease as a result of the specific infection.

A more intense edema and hyperemia may be observed as a sequel to endocarditis valvularis. In animals which die of cardiac failure or insufficiency, the lungs may become engorged with blood and may acquire a greater volume and weight than in the normal state. The interstitial connective tissue elements in such cases are apt to show a marked gelatinous infiltration. In other cases of endocarditis the detachment of small pieces of the thrombus may cause infarcts of embolic origin, which, owing to the adequate collateral pulmonary circulation, do not tend to become necrotic as they are apt to do in other organs.
The pathologic changes seen in the stomach as a result of acute erysipelas vary in degree and intensity. Whereas in a certain number of cases gross lesions may be inconspicuous or absent, a marked gastric hyperemia or inflammation is ordinarily observed in swine which have succumbed during the more advanced stage of the malady.

The mucous membrane of the fundus and the pylorus is then particularly involved. The parts are swollen and of an intensely dark red color. They may show ecchymosis and hemorrhages variable in extent and intensity. The mucosa is somewhat softened and the submucosa is edematous or presents a serous or sero-sanguinolent infiltration. The affected areas are frequently found to be partly covered by a tenacious mucus, either glary or opaque. The inflammatory process often involves the glands of the mucosa, which as a result may be visibly thickened. In certain areas the epithelium may have disappeared and here and there superficial, dry, necrotic patches of a brownish tint complete the picture.

The lesions encountered in the intestines of erysipelas-affected swine are of a character comparable to the ones observed in the stomach. The mucosa, especially that of the duodenum and jejunum, is hyperemic and swollen. It may present punctiform or even larger hemorrhagic areas. The adenoid tissues of the gut are apt to be hyperplastic and to stand out prominently from the surface, and not uncommonly they are surrounded by a deeper red zone. In places the intestinal epithelium may have disappeared and small, shallow erosions may be seen. The submucosa is frequently observed to be edematous.

Occasionally the large intestines may show evidence of participation in the general infection and to present changes of which the character does not greatly differ from the ones seen in the small intestines.

The liver is commonly found to be enlarged and engorged with blood. The organ presents a reddish brown color, which, after exposure to the air, tends to assume a lighter hue. Some degree of parenchymatous degeneration is usually observed by histologic examination, but such changes are usually obscured by the dark color of the organ as a gross specimen. As a result of degenerative changes the liver tissue may become quite soft and friable.

The aspect of the kidneys after death due to swine erysipelas may differ in accordance with the nature and intensity of the changes brought about by the infection. These organs are always damaged and this is especially expressed by necrobiosis of the parenchyma, by acute inflammation, and by the presence of hemorrhages in the interstitium. The kidney is usually enlarged, soft, and moist upon section.

The parenchymatous changes are not always apparent to the naked eye, as they are commonly masked by the dark color induced by hyperemia and hemorrhages. The latter either appear as small punctiform specks in the cortex, as more extensive dark red areas in individual lobules, or as a diffused hemorrhagic infiltration throughout the entire organ. Its medullary portion usually exhibits a lighter tint than that of the cortex even if its color may be darker than in normal kidneys.

The lesions present are essentially those of a glomerulonephritis, indicated by the punctiform red specks appearing on the lustreless, dark, swollen surface of the incised cortex. This type of hemorrhagic nephritis, according to Henschen (44), may be regarded as having a diagnostic significance. The histologic
examination of such kidneys shows the hemorrhages to be especially grouped around the glomeruli, while the epithelium of the excreting renal tubules are involved in a more or less marked degree of necrobiosis.

Henschen (44) describes a focal necrotic glomerulitis, which appears to be encountered in cases of the endocarditis of swine erysipelas. A variable number of glomeruli may be involved and not all of the vascular loops of a given glomerulus may be affected.

Recent or older infarcts may be observed in the kidneys of endocarditis cases. They are of embolic origin and come about through vascular occlusion. They often appear as wedge-shaped necrotic areas which, in prolonged cases, may become replaced by granulation tissue, the damage being eventually repaired by cicatriziation. Small hemorrhages may be seen in the mucosa of the renal pelvis and occasionally a catarrhal pyelitis engages the attention of the observer. Hemorrhages have likewise been seen in the urinary bladder, which may or may not contain a highly colored urine in which albumin can be demonstrated.

The central nervous organs are found to be congested. Small hemorrhagic points may be seen and, in a few cases, larger outpourings of blood into the substance of brain and cord were disclosed by examination.

The endocarditis (Fig. 5) of chronic swine erysipelas, of which the clinical manifestations have already been described, is the result of the localization of the causative microbes on the endocardial lining of the valves. There is reason to believe that the bacilli are carried there by the blood passing through the heart. Whether or not they may be primarily derived from the blood vessels and the lymph vessels of the valves per se, has thus far remained an open question.

The initial lesions are not usually observed, but it seems probable that they consist of small defects in the endothelium of the endocardium, which then may serve them as ports of entrance. The organisms may be transported by the blood as single units or when contained in the leucocytes or other cellular elements of the blood. Once localized in the parts concerned, the microbes multiply rapidly and tend to bring about the proliferative, inflammatory process, which gives rise to the characteristic changes encountered in well-developed cases.

Concurrently, fibrin is deposited on the damaged or inflamed surfaces and as the inflammatory process on and within the underlying endocardium advances, small, wart-like, grayish, or reddish-yellow excrescences begin to protrude from the valve surfaces and borders. More fibrin becomes deposited, while the continued connective tissue proliferation is accompanied by vascularization and organization. Thus a thrombus is formed of considerable volume which gradually begins to occlude the auriculoventricular aperture. At this stage the thrombus assumes the appearance of a warty, cauliflower-like mass by which the valves become distorted and functionally impaired.

The thrombus is composed of granulation tissue and superimposed masses of fibrin. As time goes on, connective tissue proliferation proceeds, resulting in a more or less firm structure. When the deposits are carefully removed before organization renders this difficult, shallow ulcers of the endocardium may be revealed. Fibrin continues to be deposited on the warty surfaces, thus adding to the volume of the mass. The productive inflammatory process may
extend into the depth of the tissues as far as the myocardium, where it terminates in a white scar-like formation. The thrombus commonly contains a felted mass of bacilli which is usually most conspicuous in the superficial layers.

The changes described are most frequently found in connection with the mitral valves and occasionally the aortic semilunars are also involved. Lesions of the tricuspid valve are not rare and sometimes they occur singly, while the valves of the left heart have remained intact. Involvement of the pulmonary valves is seen only in exceptional cases. In rare instances lesions of the intima of the aorta have been observed.

The thrombus formation results in a marked stenosis of the ostia concerned and, as a consequence, a more or less pronounced passive hyperemia of various parts and organs as a common sequel. As a further result of the stenosis, the heart chambers become dilated, while the myocardium becomes hypertrophic. The organ is then manifestly enlarged and its unusual size, compared with that of the adjacent lungs, is readily noticed. Occasionally, in cases which have terminated in sudden death, the wall of the right ventricle is found to have been ruptured.

Particles of fibrin becoming detached from the thrombus may give rise to embolism in more remote parts, causing anemic infarcts in certain organs. In the rather rare cases, which apparently recovered, evidences of repair and compensation are observed, but not without leaving certain remnants of the original damage.

The arthritis of chronic swine erysipelas is probably initiated by a synovitis induced by the bacilli which found their way into the articular cavity. The latter contains an excess of a reddish, flaky, synovial fluid in which the microorganisms may be present in large numbers. With the persistence of the infection, granulation tissue forms and connective tissue proliferation gives rise to the formation of elongated tags or threads either attached to the synovial membrane or freely suspended in the joint fluid.

As a result of the chronic inflammation the capsular ligaments become thickened and a marked degree of periarticular induration may be observed. The articular cartilages may or may not be eroded, although the latter is of common occurrence. Periostitis and ostitis with the formation of osteophytes may be observed in some of the cases.

**DIAGNOSIS**

The outright diagnosis of swine erysipelas in its septicemic form by its clinical manifestations only, is always difficult and quite frequently impossible. Even in countries where the disease is of perennial occurrence, veterinary practitioners are agreed that nothing is beset with more difficulties than a diagnosis in the case of swine with a high temperature, an impaired appetite, and a general dull and listless appearance. Without methods other than mere clinical observations, even a diagnosis in cases where an actual outbreak is in progress remains a task to be approached with prudence.

If swine erysipelas were the only disease to be considered, a clinical diagnosis would perhaps not constitute a serious problem. However, as other disorders of a septicemic nature must be taken into account and as, further-
Fig. 3.—Erysipelas bacilli in smear from spleen of pig.

Fig. 4.—Erysipelas bacilli in blood of an inoculated test-pigeon. Bacilli occur sparsely between the blood cells as conglomerations or are contained in leucocytes.
Fig. 5.—Swine erysipelas. Valvular endocarditis.
more, they so frequently present a similar clinical picture, the diagnosis often remains a provisional one in spite of caution and clinical skill.

Typical skin symptoms may be helpful and in the urticarial form of the malady they may even be conclusive. Yet, the ordinary erythema of the more malignant disease cannot always be clearly distinguished from the one which may be present in certain other septicemic disorders of swine. In the outbreaks of swine erysipelas occurring in this region, pathognomonic skin lesions apparently are commonly absent or may be masked by the pigmented skin of the predominating breeds of swine. If this observation is generally correct, the possibility of a ready diagnosis in the field is reduced to that extent.

The sudden onset of acute erysipelas and its rapid evolution may arouse suspicion but in the absence of an accurate case history may after all be misleading.

The character of the lesions not uncommonly observed in swine dead with erysipelas is such that the diagnostician should arrive at a conclusion with caution. Certain pathologic changes may, however, be accepted as more or less significant.

Poels (78) states that an evenly distributed erythema, redness of the subcutaneous adipose, enlargement and hyperemia of the lymphnodes (especially the mesenteric ones), enlargement of the spleen, nephrosis, combined or not with renal hyperemia, a simple, acute gastro-enteritis, and the absence of inflammatory changes in the lungs are almost pathognomonic.

Glässer (28) is of the opinion that after the usual course of the disease, aside from skin lesions, gastro-enteritis (the latter confined to the small intestines), swollen grayish blue or bluish red mesenteric lymphnodes, hemorrhagic nephritis, a hyperplastic or enlarged hyperemic spleen are, in general, sufficient to warrant a diagnosis of swine erysipelas.

Wherever no other swine diseases of a septicemic character have to be considered, a diagnosis based upon the above-named findings can, without doubt, be made with a certain degree of accuracy. On the other hand, in a region like ours, where such a disease as hog cholera has always to be reckoned with, great care is indicated and, if possible, diagnostic methods, which to a greater extent permit the exclusion of error, may well find application.

Among these, bacterioscopic and bacteriologic examinations are of the greatest value and are often fully applicable in the field.

The purpose of a bacterioscopic examination is the demonstration of the erysipelas bacillus in the blood of animals suspected of being affected with the malady. When consideration is given to the fact that swine erysipelas is the only disorder of swine in which a microorganism of the size, form, and staining characteristics peculiar to the erysipelas bacillus can be demonstrated, the great diagnostic importance of a bacterioscopic examination becomes at once apparent.

For the purpose of such an examination smears are prepared, preferably from the spleen, the cortex of the kidney, and the heart blood. If at all possible, the smears should be prepared as soon as possible after the death of the animal concerned. In the face of advanced decomposition the red bone marrow is the material of choice, as this tissue is one of the last to show putrid changes.
The smears should be quite thin and after they have dried they should be quickly passed through the flame for the purpose of fixation. They are then ready for staining. Gram's method is the one to apply. The staining solution recommended by Hucker (Abs. Bact. 6:2, 1922) is one quite suitable for the purpose. It is prepared as follows:

**SOLUTION NO. 1**
- Crystal violet ........................................... 4 grams
- 95% alcohol ............................................. 20 cc.

**SOLUTION NO. 2**
- Ammonium oxalate ...................................... 0.8 gram
- Distilled water q.s. ................................... 80.0 cc.

Solutions No. 1 and No. 2 are then mixed together and filtered.

**SOLUTION NO. 3**
- Iodine crystals ......................................... 1 gram
- Potassium iodide ....................................... 2 grams
- Distilled water ....................................... 300 cc.

A few drops of the final crystal violet solution are placed on the dried and flamed smear for one or two minutes and then washed in water. The darkly stained slide is next covered by a few drops of the iodine solution for a minute or more. After again being washed in water, it is immersed in 95 per cent alcohol for 30 to 60 seconds while being gently agitated. Again washed in water and blotted dry, the smear may now be conveniently counter-stained for a minute or two in a one per cent solution of eosin or a 10 per cent solution of carbol fuchsin in order to obtain the color contrast which materially facilitates the examination. The last stain is removed by washing in water and after the stained preparation has become thoroughly dry it is examined under an oil immersion objective. The oil can be applied directly on the stained surface of the slide. When present, the tiny slender bacilli, colored a purplish black, can be distinguished on the pink or red stained background of the tissue elements.

When a bacteriologic diagnosis is to be made from material in which the bacilli are very scarce or in which a marked degree of decomposition is apt to lead to difficulty, recourse may be had to animal inoculation. For this purpose the common pigeon is most suitable, although the white mouse used in laboratories will serve as well. As the latter animal may not always be available to the country practitioner, the selection of the pigeon may be preferable.

The material to be inoculated consists of a suspension in physiologic salt solution prepared from the pulp of the spleen, the cortex of the kidney, the red bone marrow or the heart blood, which preferably are mixed together. After passing the suspension through a bit of absorbent cotton in order to remove the coarser particles, from 0.5 to 1 cc. of it is injected into the pectoral muscles of the pigeon.

In the event of the erysipelas bacillus being present, the inoculated pigeons usually succumb after an incubation period of from 3 to 5 days. The spleen, kidneys, and heart blood (Fig. 4) of these animals can then be subjected to the bacterioscopic examination described above in order to render the diagnosis more secure.
The fact that such antibodies as precipitins and agglutinins can be demonstrated in the blood of animals infected with erysipelas led to the hope that specific serum reactions may prove to be an aid in diagnosis. Up to the present, serologic methods have apparently not found a widespread application in practice. The acute nature of erysipelas not uncommonly leaves but little time for antibodies to form to a degree sufficient for a significant reaction. However, there can scarcely be any doubt that a dependable serologic test may be of service when the general health status of a herd of swine with reference to erysipelas must be ascertained.

Vanney (100) was apparently the first to demonstrate the presence of specific precipitins in the blood of horses hyperimmunized against the swine erysipelas bacillus. More recently Breed (10) made use of an antiserum as a means of specifically identifying the bacillus isolated from field cases by a precipitation test, with apparently satisfactory results. A single test made by the writers with a similar serum left them in doubt with regard to its specificity, as more or less plainly positive reactions were also obtained with other specific antigens.

Ascoli (2) proposed for the serologic diagnosis of swine erysipelas his thermoprecipitin test as originally designed for the diagnosis of anthrax. Isabolinsky and Patzewitsch (40) reported rather favorably on their results with Ascoli's test method. They did so, however, with reservation, stating that the method needs to be further worked out. Zagaja (103) found that his results with the Ascoli test were in perfect accord with the ones bacteriologically obtained and especially so when a decision has to be made from older material. He regards the method as a useful aid in diagnosis.

Iwicki (41) reported that although his results were not always in agreement, the thermoprecipitation test may become applicable to actual practice. However, in a later publication (42) he expressed the opinion that the sera made available to him were not sufficiently potent and that furthermore they were not strictly specific.

Finzi (21), Raebiger (80), and Seibold (89) stated that the test had failed in their hands, and Von Preisz (101), writing several years later, remarked that the opinions on the practical value of the Ascoli test are still divided. It does not appear that in the countries where swine erysipelas is a most constant problem the test has been generally accepted as one of value in routine practice.

An attempt to differentiate swine erysipelas from swine plague by means of the agglutination test was made as early as 1902 by Ercolani (18). He observed in the blood of swine affected with erysipelas agglutination titers of 1:50 and 1:70, but as the blood of animals affected with swine plague also agglutinated in dilutions of 1:5 and 1:10 and vice versa he regarded the reactions as too feeble and did not consider them sufficiently specific to be applicable to diagnosis.

Since Ercolani's attempts no further efforts to develop an agglutination test of practical value were apparently made until acute swine erysipelas declared itself in this country, when Schoening, Creech and Grey (85), and Schoening and Creech (86, 87, 88) with apparent success worked out an agglutination test technique by which specific antibodies may be revealed in the blood serum. The results of trials made by Schoening and his coworkers indicate that the agglutination test may be helpful in diagnosis. His technique is quite
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simple and in its application closely resembles the one now generally em­
ployed in the control of pullorum disease. It may be used as a tube test or in
accordance with the rapid plate method. The latter appears to be the most
suitable one in field work. The tube test, which is more complicated, is more
or less restricted to laboratory practice. In either method the use of clear
serum is to be preferred to that of the whole blood.

According to Schoening and Creech (88), specific agglutinins appear in
the blood rather early in the disease, i.e., two to five days after the appearance
of the first symptoms. Best results were obtained with the blood of animals
showing evidence of arthritis. This observation confirms the one by Stiles
and Davis (96), who reported that of 203 swine affected with arthritis, 194
showed positive reactions to the rapid test and nine reacted negatively. The
joints of 151 of these cases were subjected to a bacteriologic examination and
the specific organisms were recovered from 47 of them. Of forty positive blood
cases the synovia also yielded positive reactions. On the other hand, Stiles and
Davis (96) obtained only negative results of the rapid test of the blood of all
the acute cases encountered by them. In five cases of the urticarial form of the
disease negative results were also obtained.

Similar observations were also recorded by Schoening and Creech (88) in
connection with animals showing involvement of the skin. The same authors
(86) made bacteriologic examinations of the tonsils of 87 apparently healthy
swine from a herd in which some time prior a disease had occurred, which
was suspected to be swine erysipelas. In only one of these 87 swine was the
specific organism found to be present. When the blood of these animals was
subjected to the agglutination test a negative reaction was obtained with 60
of the blood samples, 18 showed a suspicious reaction, and in nine a positive
one was observed.

Schoening and Creech (86) further observed that the serum of apparently
normal hogs tended to cause more or less agglutination in the lower dilutions.
On the other hand, with serum of spontaneous cases of erysipelas, reactions
were obtained in dilutions of 1:200 and in the majority of cases in dilutions of
1:1000 and higher.

In another publication (87) by the same authors mention is made that it
was experimentally demonstrated that the subcutaneous injections of 30 cc. of
swine erysipelas anti-serum brought about a passive transfer of the specific
antibodies. They also reported that the blood serum of a human case, of which
the history and clinical symptoms strongly indicated swine erysipelas, reacted
positively in a titer of 1:1000 and that after a lapse of 4½ months the agglu­
tinins had apparently disappeared from the serum.

Schoening and Creech (88) pointed out that animals which may have sus­
tained a mild attack of the disease and recovered may still show evidence of
agglutination when their blood was subjected to a test. Likewise, animals that
may have been exposed to the infection or those which may carry the bacilli in
some of their organs may also show, to a limited extent, the presence of
specific antibodies in their blood.

Although sufficient evidence has been submitted to leave no doubt in regard
to the specific character of the agglutination reaction, it seems probable that
the test as a means of diagnosis will have a rather restricted range of usefulness.
Apparently its revealing properties are more manifest in the chronic forms of the malady and in otherwise prolonged cases than in the more acute ones.

When, for instance, at the onset of acute sickness of one or more hogs, the veterinarian must quickly differentiate between erysipelas and hog cholera, the test may not be decisive. In the early stage of swine erysipelas, the specific antibodies may not yet be present in the blood in a degree sufficient for a significant reaction. Even a positive reaction in this type of case may not enable one to exclude hog cholera accurately unless the swine concerned were known to be immune to this disease. One should remain aware of the fact that swine erysipelas and hog cholera may coexist in a herd of swine.

As there are indications that in swine erysipelas territory many apparently normal swine show positive blood titers, such reactions should not be regarded as conclusive in the differential diagnosis between hog cholera and acute swine erysipelas. On the whole it seems probable that on more or less infected farms a negative agglutination may be more significant than a positive one. If agglutination tests must be resorted to, it is advisable to subject the blood serum of several, if not all, animals of the herd to the test.

The difficulties frequently encountered in the diagnosis of swine erysipelas from the mere clinical and post mortem manifestations have already been pointed out. It is obvious that these difficulties are all the more to be appreciated when the disease has to be promptly and correctly recognized in outbreaks where, as in Nebraska, other septicemic swine diseases must be taken into account.

Among the latter, hog cholera is the most prevalent in our region. Acute suispestifer (pig typhus) septicemia is less frequently observed, but should not be overlooked as a possible source of confusion.

Although without recourse to bacterioscopic or bacteriologic methods a differential diagnosis may remain difficult or inconclusive, certain recorded observations made in the field may, nevertheless, be helpful to the veterinary diagnostician.

Suispestifer infection is quite common among Nebraska swine; as a rule it manifests itself in a subacute or a more or less chronic form. Although the more lingering forms of pig typhus preponderate, the disease may also manifest itself as an acute septicemia and as such may be observed in older swine. In the latter case it may sometimes be difficult to distinguish the disease from swine erysipelas and for a definite diagnosis a bacteriologic examination may prove to be indispensable.

The lesions in such cases may not be particularly pathognomonic and are apt to resemble the ones observed in any of the septicemic disorders. Yet it may be worth remembering that in very acute suispestifer infections a diphtheritic enteritis may not be absent.

Manninger (58) observed that the appearance of the enlarged spleen in paratyphus (suispestifer) infection, as compared with the one found in swine erysipelas, may show certain differences of diagnostic importance. According to this author, the spleen of acute paratyphus is but slightly softened or not at all and that instead of the reddish brown color observed in erysipelas its color is dark or even blackish brown.

Hog cholera, the most prevalent of our acute septicemic diseases of swine, constitutes the more frequent problem in differential diagnosis. As a possible
factor of error it should always provoke caution. In herds of swine which were adequately immunized against hog cholera the possibility of a mistaken diagnosis of swine erysipelas is, of course, materially reduced. However, the manner and time of vaccination and the health status of the herd when this was done cannot always be ascertained, and so-called post-vaccination "breaks" may have to be reckoned with.

In swine erysipelas the onset of the attack, as a rule, is more sudden and abrupt and its course is more rapid and precipitate, while higher body temperatures may be observed than in hog cholera. In the latter, the clinical picture of the animals involved is usually more uniform than in erysipelas.

The history of outbreaks or cases, although not always to be trusted, may reveal facts which at least may be significant. As pointed out by Harrington (30), an owner's report that at some time prior to the attack the herd had been observed to be lame and had either died or recovered is warrant for the suspicion of swine erysipelas. When later on such a herd becomes involved in the disease, almost invariably there will be one or more animals which show a peculiar stiffness and stilty gait and such cases are most likely to prove to be erysipelas.

Sudden, unexpected deaths in a herd of swine are more often observed in swine erysipelas than in hog cholera. Hays and Harrington (32) called attention to the evidence of pain manifested when stiff and lame hogs affected with erysipelas are being disturbed. In hog cholera, on the other hand, the swine more definitely and permanently lose their appetites and although greatly depressed and showing a pronounced muscular atony, they are less apt to evince pain when they are handled or caused to move. It was further noted by them that in swine erysipelas, the eyelids are not usually glued together, as may be so often observed in hog cholera.

The skin changes of swine erysipelas and hog cholera cannot always be distinguished from one another, although the oft-stated fact that, unlike erysipelas, the erythema of hog cholera cannot be made to disappear by pressure, may be given consideration. On the whole it may not be safe to base a diagnosis on the appearance of the skin. The evidence pertaining to cutaneous symptoms, submitted by various observers, is quite often of a contradictory nature.

Even the pathologic examination does not regularly enable one to clearly differentiate swine erysipelas from hog cholera. Yet the presence, nature, and distribution of certain lesions may be more or less indicative. In hog cholera the lymphnodes are more apt to be hemorrhagic and frequently have assumed a more markedly dark-red discoloration. In cholera such changes appear more generally throughout the body in lieu of being confined to the regional nodes of certain organs, as may be the case in erysipelas.

In hog cholera, the tendency toward large and small hemorrhages in various parts of the body is commonly more pronounced than in cases of acute erysipelas. In this connection it must, however, not be forgotten that certain cases of true hog cholera may show but few lesions or even none at all. Such cases may be particularly observed during the initial stages of an outbreak.

A careful inspection of the spleen is always warranted. In a considerable number of erysipelas cases this organ is moderately enlarged, whereas in uncomplicated hog cholera this organ is ordinarily of normal volume. Only when a simultaneous suipestifer septicemia is a complicating factor, may en-
larged spleens be encountered in cholera cases. Then the appearance of these organs does not differ from the ones observed in independent suispestifer infections. It is well to take this possibility into consideration wherever pig typhus is of common occurrence, as in Nebraska.

Close attention should also be given to the intestines, because in swine erysipelas lesions are more commonly found in the small intestines, whereas in cholera they are more frequently observed in the large ones. In case of the latter, a hemorrhagic mucosa is quite common and cecum and colon may be involved in a hemorrhagic-diphtheritic enteritis.

Pulmonary lesions of an inflammatory character are not infrequently met with in hog cholera and then more or less characteristic petechiae and ecchymoses of the visceral pleura are often observed. In acute erysipelas, inflammatory lung lesions are rare. In the more prolonged cases there may be edema and passive hyperemia. Petechiae of the various mucosae are more regularly observed in hog cholera than in swine erysipelas.

In acute erysipelas the kidneys are commonly involved. There may be a hemorrhagic nephritis and degenerative changes in the parenchyma, which are quite characteristic of this malady. In both diseases small petechial hemorrhages may be visible on the kidney surface (glomerular hemorrhages) and these may sometimes be a source of confusion. It is, however, very doubtful that anything approaching the typical "turkey egg" kidney of hog cholera has ever been encountered in swine erysipelas. Such a feature may be possible, but must be extremely rare.

Owing to the great importance of a reasonably prompt and accurate differential diagnosis between hog cholera and swine erysipelas, the bacterioscopic or bacteriologic examination must often be relied upon. Even when a tentative diagnosis has been made, veterinarians to whom swine erysipelas may still be a more or less unfamiliar disorder may do well to control their diagnoses by these more precise methods or to have this done for them by a diagnostic laboratory. No doubt, to do so will enhance their ability to cope with future problems of this sort. As a further means, helpful in the diagnosis of cases in which there is uncertainty and in which swine erysipelas is to be considered, the injection of adequate doses of swine erysipelas antiserum into a few animals yet in the earliest stages of sickness may be resorted to. In erysipelas animals thus treated, a marked improvement, if not evidence of recovery, will frequently be observed within 24 hours, a phenomenon not apt to present itself in hogs affected with cholera.

Such a makeshift method of diagnosis may not always lead to conclusive results but on occasion it may furnish a more or less significant indication.

**PROPHYLAXIS**

In the prevention of swine erysipelas, general hygienic practices as well as immunization must be depended on.

Among the measures of prophylactic value, the prevention of contacts between healthy swine and the ones affected with erysipelas always should be kept in mind. Of equal importance is the exclusion of healthy swine from enclosures and pastures in which the disease has occurred. Such areas should not be occupied by susceptible hogs for an extended period.
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Even in the beginning of actual outbreaks the removal of swine still in good health (with normal temperatures and appetites) to some part of the farm not known to be contaminated is a measure essential in prevention. If it should be possible to divide such healthy swine into smaller units, kept separately, this would add to the safety of the whole.

The prevention of the spread of the disease from farm to farm cannot be overemphasized at the present, when the infection has not yet acquired a maximum distribution. Traffic in swine should be under a more rigid supervision and control. Public sales establishments, which are apt to have apparently healthy hogs from infected herds consigned to them, may materially protect the interests of their buyers by causing all swine passing through their hands to receive protecting injections of anti-swine-erysipelas serum. No small amount of mischief may be prevented by such a simple and relatively inexpensive measure.

The prevention and control of swine erysipelas may be attempted by the following methods of immunization: (1) vaccination, (2) serovaccination, and (3) the establishment of a passive immunity by the use of antiserum.

One of the earliest attempts to protect animals against disease by active immunization was made by Pasteur and Thuillier (73, 74) in connection with swine erysipelas. The method developed by them consists of two distinct inoculations. The animals to be immunized first receive a subcutaneous injection of 0.1-0.2 cc. of bouillon culture of attenuated erysipelas bacilli, and from 10 to 12 days later they are inoculated again with a culture of a higher degree of virulence.

For a time the Pasteur vaccines, the only means of immunization against swine erysipelas then available, found a wide application and doubtless with many good results. As experience accumulated, it became apparent that the range of the method's usefulness was subject to certain restrictions and that as a means of immunization it was not safe under all conditions which may be encountered in the field.

The best results were obtained in the immunization of the more resistant types of swine, whereas, when applied to the more refined and improved breeds, discouraging losses were frequently experienced. When used consistently before outbreaks of the malady had declared themselves the method also yielded satisfactory results. On the other hand, it was found to be associated with certain hazards when animals which already had been exposed to the infection were inoculated. In such subjects the bacilli may already be present in the body and it appeared that the addition of the organisms of the vaccines was apt to overcome the natural powers of resistance which the animals had already developed.

As a routine practice, especially in countries always more or less permanently involved, it is not always possible to exclude the hazards named and hence the reported results were not unanimously favorable.

As stated by Nocard and Leclainche (70) in France, certain veterinarians vaccinated thousands of hogs without a single accident, whereas others, operating in permanent foci of infection, observed in some herds losses amounting to 6 to 10 per cent.
Here and there, Pasteur's method still finds application, but with the advent of swine erysipelas antiserum and serovaccination it has been largely displaced by the newer and safer means of immunization.

Experimenting with rabbits and mice, Emmerich and Mastbaum (17) discovered the protective and curative properties of the blood serum of rabbits which were hyperimmunized against swine erysipelas and suggested that the use of such a serum may be applicable to the prevention and cure of swine exposed to or affected by the disease.

Based upon these findings Lorenz (52, 53, 54, 55) and Leclainche (49, 50) developed the methods of immunization against swine erysipelas which are now generally used in those countries where the disorder has to be constantly combated.

The serum is now generally obtained from horses which have previously been hyperimmunized by repeated injections of gradually increasing quantities of virulent bouillon cultures of the erysipelas bacillus. In some manufacturing institutes on the continent, bovine animals are also utilized as serum producers.

Injected with appropriate doses of serum, healthy swine become resistant to swine erysipelas within a few hours; but, as after the injection of antiserums in general, this passive immunity is only of a relatively short duration and after a more or less variable length of time such animals again become susceptible to the infection. Most observers estimate the duration of the period of passive protection at from 8 to 15 days. Von Preisz (101) relates a loss of 5 per cent within 8 to 40 days after injection, in a herd treated only with serum.

In areas where the disease is to be perennially expected to occur, the passive immunity conferred by serum alone would not make it possible to secure a lasting immunity prior to the time when, in its more malignant form, erysipelas tends to become most prevalent. Hence the problem of securing an active and thus more lasting protection presented itself. This was solved by the injection of small quantities of virulent erysipelas culture either simultaneously with the serum or a few days later.

This procedure became the basis of both the Lorenz and Leclainche methods of immunization against swine erysipelas. These methods rest on the same principle and differ only in the mode of application. With the Lorenz method the serum and culture are injected separately into different parts of the body at the same time, whereas, with the one designed by Leclainche, the appropriate doses of culture and serum are mixed in the syringe immediately prior to application and are then inoculated by a single injection.

It has been pointed out by European authors that the virulence of the culture used in serovaccination is an important factor in the results to be expected. Not only must the bacilli be fully virulent but they must also have a good capacity for growth. The use of weak or feebly virulent cultures seems to impair the duration of the immunity which follows the inoculations. On the other hand, excessively virulent cultures may become responsible for vaccination erysipelas.

Such authors as Ganslmayer (26), Hoffman (37), Manninger (58) and Prettnner (79) also call attention to the need of serum quantity and culture quantity being as nearly balanced as possible. A minimum dose of anti-serum to a given quantity of culture within the range of safety appears to promise a more lasting protection of the animals treated. This opinion finds support in
data submitted by Van Es, Olney, and Blore (99) who undertook an analysis of the immunity status of 2309 pigeons, which had survived in potency tests of anti-swine erysipelas serum. Their results revealed that the birds which had survived in the original tests showed a degree of immunity which declined in accordance with the volume of the serum doses. The ones which received the smaller doses had acquired a more lasting immunity than the ones which originally had been injected with the larger amounts of serum.

As immunization against swine erysipelas is practiced in the countries most concerned with the malady, certain distinctions are made between the procedures to be followed in healthy herds and procedures in herds already exposed to or involved in the infection.

It is always deemed advisable to immunize the swine in erysipelas territory before the seasonal incidence of the disease begins to assert itself and when the animals are still in good health. In such herds the Lorenz and Leclainche modes of procedure most generally find application. The animals are injected with the usual precautions which should always govern the technique of subcutaneous injections.

The serum doses may vary somewhat in accordance with the manufacturers' directions. Nocard and Leclainche (70) recommend 10 cc. for pigs weighing less than 100 pounds and from 10 to 20 cc. for swine more than 100 pounds in weight, and Glässer (28) estimates that 1 cc. for every 20 pounds of body weight is quite sufficient.

The dose of virulent culture, when used in simultaneous vaccination, is 0.25 to 0.50 cc. for pigs of less than 100 pounds and from 0.5 to 1.0 cc. for animals over that weight, with 0.5 cc. as the usual routine dose.

Nocard and Leclainche (70), no doubt referring to the Leclainche method, state that the culture dose is a fixed one of 0.5 cc. and that the serum dose for the first injection varies with the weight of the animals. It is 5 cc. as the minimum for pigs weighing less than 100 pounds. Beyond that weight one should add 1 cc. for every 20 pounds of additional weight, a dose of 10 cc. being enough for animals weighing 200 pounds.

The serum and culture or a mixture of them are injected at one time, although in cases in which the health status of the herd may be in doubt, the serum is injected first and the culture two or three days later. As a rule, the combined injections are made at once.

The immunity which follows serovaccination is maintained for 4 to 6 months, largely depending upon the correct proportions and quality of the materials used.

In order to secure a more lasting immunity after serovaccination, many authorities, including veterinary practitioners of wide experience, counsel the injection of another dose of culture without serum about 14 days after the simultaneous treatment. Schmidt (83) regards this second injection as absolutely necessary when the more refined and hence the more susceptible breeds of swine are to be rendered immune. Mieszner (62) recommends that in order to procure a more enduring protection, a second injection of 1 cc. of culture should follow the first one after an interval of three weeks. Glässer (28) states that by such second culture inoculations the resistance of the treated animals to erysipelas will be extended to about one year.
One should always remain mindful of the fact that serovaccination is merely a prophylactic measure and can not be depended on for curative purposes. Hence, when the veterinary practitioner is confronted by a herd of swine in which cases of swine erysipelas have already declared themselves or when there are good reasons to believe that a number of animals are already incubating the infection, another procedure is indicated.

To inject cultures under such circumstances is always more or less hazardous and to proceed in this manner may invite vaccination erysipelas. Hence, in herds already involved in the disease, one injects all animals with serum only. This not only stops further progress of the infection but often brings about recovery of hogs already sick. This primary serum treatment can, then, be followed 8 to 10 days later by serovaccination while the passive immunity induced by the initial serum dose is still more or less intact.

Serovaccination, as generally practiced in permanently infected areas, has yielded quite satisfactory results and there the procedure is being followed as a matter of routine. Joest and Helfers (43), reporting on the results of simultaneous immunization (Lorenz), stated that 81,630 swine divided over 10,076 lots were treated. Of the latter, 784 were already involved in swine erysipelas. Sickness which could be attributed to the treatment developed in 40 cases only. The disorder declaring itself after the culture injections was observed in 202 animals. There were 218 losses caused by vaccination and natural swine erysipelas, but 893 animals, already sick, recovered after serum treatment.

Nocard and Leclainche (70), referring to results obtained in France after serovaccination (Leclainche) from May, 1900, to November, 1901, report that 24,943 swine were vaccinated without any accident. They assert that the vaccination is safe for animals of any age, including pregnant sows. In regard to the latter, Glässer (28) mentions that sows advanced in pregnancy have been observed to abort, and hence he suggests that they be not treated with culture at all but only with serum. On the other hand, Fellbaum (19) and Helfers (33) regard serovaccination of pregnant sows to be entirely safe. Manninger (58) also regards the practice as a safe procedure, but counsels that all excitement of these animals should be avoided.

Schmidt (84), apparently using the Leclainche method of serovaccination, states that the serum dose of 5 cc. for swine 100 pounds in weight must also be regarded as sufficient for all heavier animals. In the course of five years, far above 10,000 swine, of which several weighed from 400 to 800 pounds, were treated with serum-culture mixture 10:1 and never received more than 5 cc. of the mixture. He further reports that up to the time of writing he had not lost a single hog from vaccination erysipelas.

Serovaccination against swine erysipelas was introduced into Nebraska in 1938. Prior to that time outbreaks of the disease were dealt with by the use of anti-serum. One of the reasons for the delay in taking advantage of a prophylactic measure so successfully applied in other countries was based on the difficulty of keeping the highly virulent culture in safe hands.

Before 1936 it was as yet by no means certain that the disease would gain a firm foothold in this country, comparable to its widespread and perennial occurrence on the European continent. The hazards of introducing the disorder into disease-free areas by a promiscuous and unwarranted sale and use
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of the culture were considerable enough to justify caution. In addition the fact that the erysipelas bacillus is pathogenic to man could not be entirely disregarded.

As it became increasingly apparent that, in the States which maintain a dense population of swine, erysipelas was gradually assuming the proportion of a major problem in live stock sanitation, serovaccination had to be resorted to. It was introduced as an experiment in which the National and State Bureaus of Animal Industry, this Station and a small number of veterinarians practicing in definite erysipelas territory originally cooperated.

Under this project a relatively small number of swine were vaccinated during 1938. The results were on the whole so gratifying that the practice of vaccination was gradually extended. Serovaccination against swine erysipelas is now widely practiced in Nebraska. The work is being continued on an experimental basis, in order that results may be accurately recorded and that the details of vaccination may be adequately controlled and safeguarded.

Available records show that between April 26, 1938, and March 31, 1942, not less than 701,889 swine in a total of 12,917 herds were vaccinated against the disease. A compilation of the vaccinations during the two year period 1939–1940 reveals that in the course of this period a total of 204,219 swine distributed over 3,214 herds were treated. Of the latter, 254 herds or 7.93 per cent of the total reported unsatisfactory results due to variety of causes, whereas no complaints were received from 2,960 herds or 92.09 per cent of the total.

Unsatisfactory vaccination results may be traceable to a variety of causes. Some vaccination erysipelas could be definitely attributed to the poor quality of serum in 1938. Since that time similar annoying results could also be recorded in the course of the vaccinations practiced during 1939–1940. However, when the number of herds and swine involved in these unfortunate results are compared with the totals of herds and swine treated during this period, their general importance becomes almost negligible.

Available data show that in the course of the period mentioned in 9 of the 3,214 herds vaccinated, vaccination erysipelas could be recorded in which 77 head of swine of a total of 204,219 animals treated were involved. In the course of the same period second injections were administered to 40,080 pigs distributed over 736 herds. In these, vaccination erysipelas was manifested by 38 swine belonging to five herds.

Probably most of the unsatisfactory results arose from the fact that not all of the vaccinated swine maintained their immunity up to the average term of six months. It seems quite possible that many cases, in which resistance to infection lapsed prematurely, may have been due to an unbalanced ratio between culture and serum dosage which impaired immunity quality. In other instances the vaccinated swine at the time of the treatment were possibly already in the period of incubation, a status for which our infected farms offer adequate opportunity. The influence of intercurrent diseases such as hog cholera and pig typhus may also have been a contributory factor in complaints.

Annoying as unfavorable results may be to individual swine owners, the actual losses among vaccinated swine are relatively quite small. As already stated, in the course of the period 1939–1940 a total of 204,219 swine were
vaccinated and among these 1,617 developed swine erysipelas after the treat­ment or 0.78 per cent of all the swine treated.

Thus far no major vaccination disasters have accompanied the carefully controlled Nebraska vaccination practice, and no case can be reported of extremely bad results, such as mentioned by Muller (67). This author relates that two months after the vaccination, swine erysipelas broke out among the treated animals in such a malignant form that curative serum treatment failed to bring about recovery.

THERAPY

The medicinal treatment of animals affected with swine erysipelas is entirely worthless. On the other hand, there is an abundance of evidence to show that swine erysipelas antiserum administered immediately after the first symptoms become manifest will bring about recovery, sometimes even with surprising promptness. Some observers found that more than 80 per cent of erysipelas-sick swine may be saved by timely serum treatment.

Joest and Heifers (43) reported the recovery of 471 (68.85 per cent) of a total of 684 hogs sick with erysipelas after serum treatment. Detre (15) relates that serum was injected into 687 head of swine affected with the malady. The ones weighing less than 100 pounds received 10 cc. each and the heavier ones 20 cc. Of the 611 animals treated only once, 33 (5.4 per cent) died. One hog developed chronic erysipelas and 577 animals recovered. On the other hand, of 76 very sick swine which therefore were treated more than once, 20 (26.31 per cent) succumbed, 50 (65.8 per cent) recovered, and six (7.9 per cent) de­veloped the disease in a chronic form.

The most desirable results may be expected only when the serum is in­jected during the earliest stage of the disease and then especially when the serum is injected in liberal quantity. Varying with the body weight and condi­tion of the animals, from 10 to 40 cc. of antiserum are injected subcutaneously or intravenously if possible. Dependable authorities recommend a repetition of the serum injection every 6 to 8 hours until improvement becomes manifest. Others counsel another serum dose 12 hours after the first one as a routine practice.

Loweg (56) continues daily injections with swine erysipelas antiserum as long as the body temperature remains abnormally high and suspends treat­ment when the temperature drops and the appetite returns. He could determine that large doses of serum on the first day of treatment are decisive. He de­clines to treat animals already showing asphyxia and subnormal temperatures.

SWINE ERYSIPelas IN ANIMALS OTHER THAN SWINE

Attention has already been called to the fact that the distribution of the swine erysipelas bacillus, so far as animals are concerned, is not wholly re­stricted to hogs. Reports referring to the occurrence of the erysipelas microbe in other types of livestock are so numerous that a detailed account of each observation may be omitted from this publication.

As may be expected, most of these observations were made in regions where the disease had gained a firm and more or less permanent foothold, where its causative microorganism is a somewhat ubiquitous inhabitant of the
soil and other parts of the environment and where its occurrence in healthy swine is frequently observed. A few similar observations have, however, also been made in this country, and it is reasonable to expect that such infections may be encountered here on farms where the disorder has declared itself among the hogs.

Apparently sheep, lambs especially, have furnished the greater number of cases in which the erysipelas bacillus has proved to be the cause of pathologic changes (Biewener, Carré, Christiansen, Köser, Névot, Ostertag, Poels, Spiegl, and others). Marsh (59) and Ray (81) have also identified the organism in lambs in this country.

In most of the cases observed in sheep the infection was localized in the joints and not unconventionally in the form of a polyarthritis, accompanied by lameness and general malaise. In at least one reported case (Spiegl) the polyarthritis was associated with an omphalophlebitis due to the erysipelas germ.

Swine erysipelas bacilli have been found in cattle showing symptoms which suggested anthrax (Broll, Schiff, Seibold) and in a cow suffering from endometritis (Weitzig). The same organism was also recovered from the horse (Pfeiler), from a dog affected with endocarditis and septicemia (Mikschoowski), and from guinea pigs (Balozet).

Various species of birds have been found to harbor the erysipelas microbe. In common fowls it was present in diphtheritic exudates and septicemic disease (Eber, Hauser, Schiff, Schmidt), or in outbreaks of chronic disorders (Pfaf). It was also found to occur in turkeys (Eber, Beaudette and Hudson). The latter (7) recently described an acute outbreak which could be attributed to the erysipelas microorganism. This germ was also encountered in the guinea fowl (Jarosch), in the duck (Eber, Poels), and in the parrot (Jarmai).

There is abundant evidence to show that the swine erysipelas bacillus is frequently associated with fish and shellfish. (Harkins, Klauder, Kondo and Sugimura, Stefansky and Grünfeld).

**SWINE ERYSIPELAS IN MAN**

Cases in which swine erysipelas infection has been transmitted to man are by no means rare and the possibility of such an infection hazard should not be overlooked by persons in more or less direct contact with affected swine, or with its causative germ in the field or laboratory.

It is apparent from European statistical evidence that since the introduction of the use of virulent cultures in immunization practice, the cases of swine erysipelas in man have become more numerous.

As a general rule, human swine erysipelas or erysipeloid, as it is designated in medical literature, is the result of wound infection. Veterinarians who puncture their fingers with the inoculating cannula supply the large proportion of the erysipeloid cases. Small wounds or abrasions on the hands of persons performing autopsies or during butchering activities are common ports of entry of the infection.

After an incubation period of one to five days the skin of the finger or hand around the site of inoculation becomes swollen and red, a color which may deepen into a purplish hue. The swelling and discoloration gradually extend,
the advancing border sharply delimited, assuming a dark red color. The affected skin is somewhat raised above its normal level. The surface is usually smooth, although in some cases wheals and vesicles may be observed. These phenomena may be accompanied by fever as well as by swelling and tenderness of nearby joints and the regional lymph nodes. On the whole, the skin lesion of the hand but rarely extends beyond the wrist.

In erysipeloid the absence of suppuration is a characteristic feature, although some pus may have formed in the punctured wound which admitted the specific microbe. The evolution of the disease is usually accompanied by an itching, stinging, burning, or prickly sensation. In the preponderating number of cases the disease remains localized, but a general infection may come about when the lymph nodes fail to arrest the further progress of the infection. Endocarditis as a sequel to erysipelas has been very rarely observed.

The majority of erysipeloid cases pursue a benign course and terminate in recovery in the course of from two to four weeks. Occasional relapses may have to be reckoned with.

The treatment consists in the application of antiseptic compresses and the elevation and complete rest of the affected parts. Injection of the specific antiserum frequently results in a speedy amelioration and recovery and when given in sufficient doses may tend to prevent relapse. From 5 to 20 cc. of the serum are recommended as a dose and its injection should not be omitted in cases showing evidence of systemic involvement or in those which show signs of extension of the infection beyond the parts primarily involved.

Whereas the swine erysipelas bacillus associated with erysipeloid is not uncommonly derived from organs or flesh of infected animals, medical or veterinary literature supplies no evidence to indicate that the consumption of pork was responsible for the disease in humans. The only case in which this mode of transmission could be given consideration is the one reported by Fiessenger and Brault (20). In this instance the patient developed the disease in a form comparable to the acute septicemic erysipelas of swine, after the ingestion of salted pork. The diagnosis was confirmed by blood culture. The patient improved rapidly under serum treatment, but in the course of convalescence an acute nephritis and cardiac failure intervened with lethal results.

Although there can be no doubt that this patient suffered from a swine erysipelas infection, the part played by the pork remains somewhat uncertain in view of the case history, which reveals that the suspected meal was partaken of at midday and that illness was already in evidence in the course of the evening following. Such an extremely brief incubation period, particularly so after ingestion, somewhat impairs evidence tending to point to the pork as the primary infection source.

That erysipeloid is not always acquired through contact with swine or virulent cultures was shown by Klauder (47), Harkins (29), and Klauder and Harkins (48), who gave an account of the disease occurring on the hands of fishermen along the Atlantic seaboard. The disorder presented a high morbidity and supplied the cause of disability among these men. The infection was, without doubt, acquired from the fish.

A similar observation was made by Stefansky and Grünfeld (92) who, reporting from Odessa, described an outbreak of erysipeloid in which approximately 200 persons became involved. They acquired the infection
through wounds of the hands while engaged in the cleaning of fresh-water fishes. The swine erysipelas bacillus was bacteriologically shown to be the etiologic factor.

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