Bulletin 419 June 1953

Facts about . . .

NEWCASTLE DISEASE

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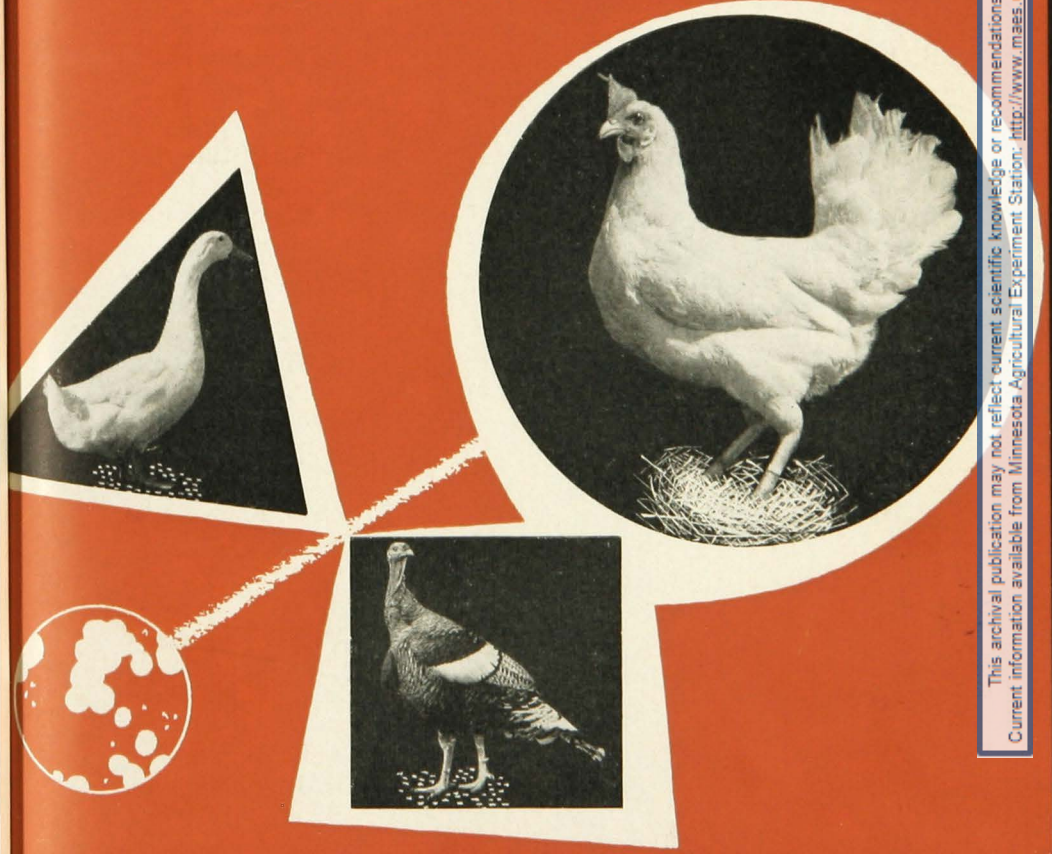

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YEARLY LOSS TO POULTRY INDUSTRY

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NEWCASTLE DISEASE

B. S. Pomeroy and C. A. Brandly[1]

NEWCASTLE DISEASE is a specific, highly contagious disease affecting chiefly chickens and turkeys. Other poultry, as well as various species of wild birds, may be attacked also.

Importance to Poultry Industry

Newcastle disease is now considered one of the most important diseases of poultry and is by far the most serious disease encountered in the chicken broiler industry. Experienced poultrymen know that Newcastle disease causes severe losses directly but few realize the hidden toll the industry pays to the disease each year.

The actual loss of birds to the disease is felt keenly by the owner. Although practically 100 per cent of the birds get the disease in any given outbreak, the losses may vary from one outbreak to another, depending on several factors. In baby chicks the loss may be as high as 100 per cent but the average loss may be 30 to 40 per cent.

The chicks that survive an outbreak will show poorer growth and lower efficiency of feed utilization. Approximately two more weeks are required to finish birds in affected broiler flocks. In turkey poults, the loss is not as high as in chicks but may be 15 to 20 per cent of a brood.

In laying birds, the death loss may be only 1 to 2 per cent but occasionally may be as high as 80 per cent or more. The greatest loss comes from the effect of the disease on egg production and egg quality. In breeder flocks, the disease has additional detrimental effect on fertility and hatchability of the eggs.

Further evidence of the losses to the poultry industry is the restriction on exportation of live and dressed fowl from the United States to certain foreign countries such as Canada, England, and some countries of South America. This loss of export trade is of grave concern to the industry.

The poultry and turkey industries have shown phenomenal growth in the past few years. In 1952 about 1½ billion chicks and 65 million turkeys were hatched. An estimated 1 per cent mortality to Newcastle disease means a loss of 15 million chickens. In addition to the mortality, the loss from effects of the disease would make a total loss to the industry of 30 million dollars.

In order to live with Newcastle disease about 500 million birds are vaccinated annually for this disease. Thus, to get this protection the cost to the industry is estimated at 10 million dollars.

[1] Publications subcommittee of the North Central Regional Technical Committee for Newcastle Disease Project NC-6. Dr. B. S. Pomeroy is professor of veterinary medicine at the University of Minnesota, and Dr. C. A. Brandly is professor of veterinary science at the University of Wisconsin.

Any figure for losses caused by Newcastle disease in poultry must be a broad estimation. In arriving at a final estimate of around 40 million dollars for the yearly losses suffered directly and indirectly because of Newcastle disease, every effort has been made to lean toward the conservative side.

Although Newcastle disease is not a serious threat to public health, man may become infected with the virus and suffer a mild infection of the eyes. There is no evidence at the present time that Newcastle disease virus has any relationship to nervous disorders in man such as poliomyelitis.

History

Newcastle disease was first recognized as a distinct and separate disease of chickens in 1926 after outbreaks occured in England and in the Dutch East Indies. Dr. T. M. Doyle showed that the malady in a flock near Newcastle-on-Tyne, England, was a virus disease which differed from fowl pest. He named the disease after the town of Newcastle.

The outbreak in England was promptly stamped out by quarantine of the premises, slaughter of infected and exposed flocks, and disinfection of contaminated material and equipment. Recognition of the disease in the Dutch East Indies was not followed by eradication and subsequently the disease has eventually spread to every poultry-producing country of the world.

Newcastle disease appears to have spread between continents largely along channels of trade. All earlier outbreaks in a previously free continent were near seaport towns. Evidence would suggest that the introduction came from infected birds or their inedible parts that had been brought to the country by ship.

Newcastle disease apparently reached California about 1940. There, because of its unusual nature, it went unrecognized until 1944. Then the virus of the new respiratory-nervous disorder which the California workers called pneumo-encephalitis was shown to be identical with the virus of Newcastle disease. In 1945, Newcastle disease was found on the eastern seaboard—first in New Jersey and New York. By 1947 the infection had been reported in 30 states and within a year or two it had spread to every state reached by traffic in poultry and poultry products.

Cause

Newcastle disease is caused by a virus, an infectious agent too small to be seen with the ordinary microscope. The virus can be grown in the laboratory in fertile chicken eggs that have been incubated for about 10 days. This method of growing the virus provides a means by which the virus may be isolated from affected fowl, animals, and man. It also provides a method for studying the virus in the laboratory and making vaccines that may be used in the control of the disease.

The virus of Newcastle disease causes certain changes in the embryonated chicken egg that gives us evidence of its presence. Death of the embryo in two to four days, small hemorrages on the membrane around the yolk and on the skin of the embryo are visible re-

actions. Another means of detecting the presence of the virus is the ability of the fluid from an infected egg to cause clumping of chicken red blood cells and other mammalian blood cells. This clumping phenomenon is known as hemagglutination and is very useful in the study of Newcastle disease. The terms hemagglutination and hemagglutination inhibition refer to this test.

Species of Birds and Animals Affected

Since Newcastle disease was first identified as a disease of chickens, various species of poultry and birds, as well as certain mammals including man, have been found to contract the disease by natural exposure. The susceptibility of a variety of species to infection by inoculation with Newcastle disease virus indicates that all species of birds and some mammals are subject to infection. The wider prevalence of Newcastle disease among chickens has led to rather abundant and extensive exposure of other birds and mammals. The expected result of such greater exposure is that the Newcastle disease virus or, at least those strains with active abilities to do so, will have more opportunity to become adapted or adjusted to new hosts, perhaps in the way that pullorum disease has become a serious malady of turkeys as a result of contact with diseased chickens.

Other than chickens and turkeys, the following species of birds have been reported as affected with Newcastle disease in nature: pheasants, ducks, geese, guinea fowls, pigeons, swans, parrots, quail, partridges, sparrows, crows, mayas (martins), starlings, doves, owls, and gannets.

So far the infection of human beings has been recognized only as a relatively mild pink-eye-like infection contracted by handlers of sick or slaughtered birds or by diagnosticians or laboratory personnel working with the virus. Ducks, geese, and other birds may show little, if any, evidence of the disease upon being infected, yet they may act as carriers and spreaders of Newcastle disease virus. Persons as well as cats, dogs, and other species perhaps may also serve as unrecognized or "blind" carriers and spreaders of Newcastle disease infection.

Modes of Spread

The actively infected individual, as well as the apparently healthy carrier, is the reservoir of Newcastle disease virus. The virus is given off with the saliva, nasal secretions, and droppings before symptoms of Newcastle disease appear, frequently within one to two days after exposure to infection. Some individuals may have a "silent" or hidden attack and eliminate the virus for several days to a week or more. Individuals that survive a more or less severe attack of Newcastle disease seldom have been shown to harbor or give off the virus for periods longer than three weeks. The virus has been recovered from the lungs of chickens two to three months after recovery from the natural infection and in one case it was demonstrated in the lungs of a chicken about 17 months after an attack of Newcastle disease. Normal

hens placed in contact with a rooster infected six months previously developed infection five weeks later.

Other information suggests that the proportion of healthy recovered carriers of Newcastle disease virus is ordinarily quite low but the persistence for a month or more of only a small percentage of carrier cases is often sufficient to set up new centers of infection and thus to favor further spread of Newcastle disease.

If contact of succeptible birds with the virus were to be prevented for a time, Newcastle disease would soon disappear. Under conditions unfavorable to the virus outside of the living bird, Newcastle disease virus perishes in a few minutes or hours. Where the virus is protected to some degree against heat, light, moisture, and other factors that destroy it, it may survive for months.

The earlier reports from England include an instance where day-old chicks, placed in dirty battery brooders seven weeks after the removal of infected chicks contracted Newcastle disease. Others have reported that healthy stock has remained free of Newcastle disease when placed in uncleaned houses as early as three weeks after removal of an infected flock. Such an interval must be considered extremely short in view of the resistance of Newcastle disease virus and would not justify reuse of houses or quarters without an intervening period of time and thorough cleaning and disinfection.

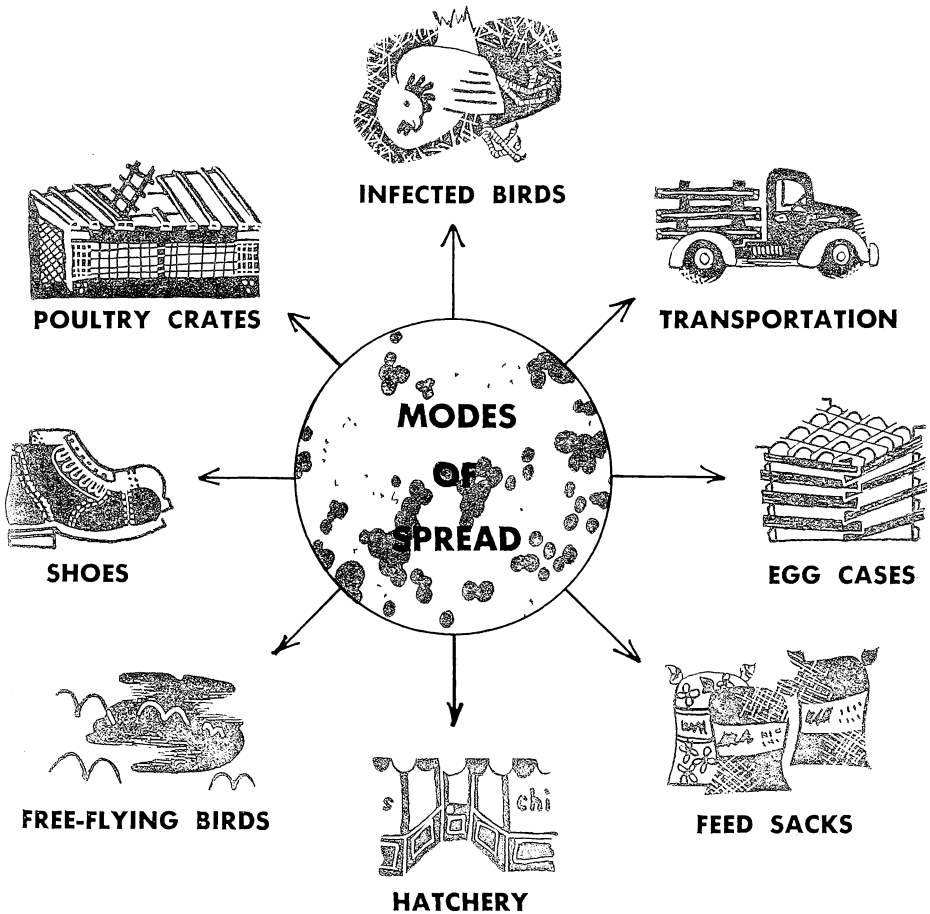
Newcastle disease virus is quite resistant to heat and can withstand a temperature of 132° F. for at least 30 minutes. Boiling water temperatures will, however, destroy it immediately. Newcastle disease virus in droppings and secretions may survive exposure to direct sunlight for several days or longer.

The common chemical disinfectants such as 1 per cent saponified cresol, 1 per cent lysol, and 0.1 per cent quarternary ammonium compounds, are effective in destroying the virus in 5 to 10 minutes. These agents, however, will not kill virus protected by dirt, droppings, or body secretions or tissues. Lye solution (1 per cent) is useful as a cleansing and scouring agent preliminary to use of disinfectants as a spray or dip. However, lye solution should not be substituted for the usual disinfectants since Newcastle disease virus is much more resistant to alkalies than many other viruses.

Fumigation of incubators with formaldehyde by the usual method used against pullorum disease will destroy Newcastle disease virus on exposed surfaces but, of course, cannot reach virus covered by masses of dirt and down or the virus within infected eggs.

It is often hard to determine just how Newcastle disease gets into a brood or flock. Obviously there are many ways that it arrives from the original reservoir in another bird or animal. The flock owner himself may introduce it by carrying the virus home on his shoes and clothing after a visit to an infected flock, hatchery, or produce plant. Baby chicks are sometimes exposed to Newcastle disease during shipment by rail, truck, or air. The local produce buyer may trade chicken crates with the flock owner at the time his cull or broiler birds are picked up. These may be a source of infection. Reused feed sacks from infected premises may carry Newcastle disease to clean flocks. Study by one investigator has shown that Newcastle disease virus can survive on strips of burlap bagging for 20 days at a temperature varying from 29 to 72° F. but another research worker later reported survival of the virus on burlap for as long as 49 days in a room at 68 to 86° F. and for 129 days in a hen house at 12 (-11° C.) to 45° F.

Newcastle disease can be "purchased" with started chicks, especially with



those bought at "bargain" rates. Free-flying birds have been responsible for bringing Newcastle disease to certain farms and flocks.

Flock-selecting and pullorum-testing crews have spread Newcastle disease from farm to farm as a result of failure to observe proper sanitary precautions. Cats and dogs can act indirectly as carriers of the virus from one place to another, especially after eating infected carcasses or contacting contaminated material.

The virus seldom, if ever, may be expected to pass from a recovered hen through the egg to the chick. Few, if any, infected eggs will hatch. Since a high proportion of eggs from flocks in the early stages of the disease contain the virus of Newcastle disease, an incubator or hatchery can become contaminated by such eggs. Virus on the surface of dirty eggs, feathers, and crates can contaminate the hatchery and incubator as can the breaking of infected eggs from such premises.

Natural Course of the Disease

PERIOD OF INCUBATION

Newcastle disease tends to be an acute infection in all species of birds and in eye infections of man. The period of incubation is the interval of time between the entrance of the virus into the host and the appearance of manifestations of disease. In Newcastle disease, evidence of disease may be noted by respiratory or nervous symptoms or a reaction to the hemagglutination inhibition or serum neutralization test as conducted in the laboratory. The minimum incubation period for the onset of respiratory or nervous symptoms is 2 days and may be as long as 7 to 10 days. It has been reported that the incubation period may be as long as 15 days with the average period being from 5 to 6 days.

SYMPTOMS OF NEWCASTLE DISEASE IN CHICKS

In chicks the most common symptoms are gasping, coughing, and hoarse chirps, while some chicks may lose their chirp entirely. The chicks are depressed with loss of appetite and tend to huddle under the brooder. Nervous symptoms of twisting head movements and paralysis usually follow respiratory symptoms. The bird may assume peculiar attitudes and movements including lateral or downward twisting of the neck, convulsive seizures, somersaulting, rearing, and walking in circles. While symptoms of difficult breathing occur in most chicks in an infected flock, the nervous symptoms may occur in only a small percentage of the chicks or may be completely absent in the flock. The respiratory symptoms usually persist in a flock for two or three weeks. The chicks that develop nervous symptoms seldom recover.

FIG. 1. Chick showing respiratory symptoms of Newcastle disease.

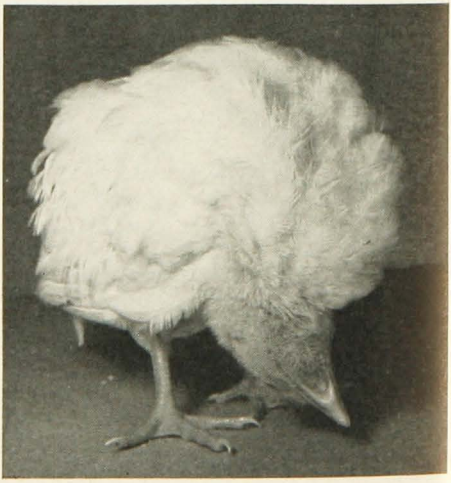


FIG. 2. Chick showing nervous symptoms that follow respiratory phase of Newcastle disease.

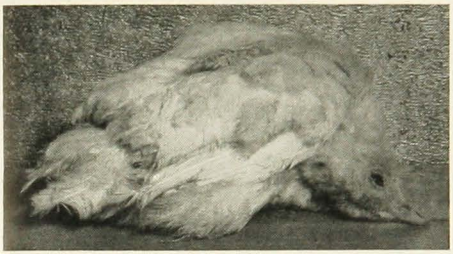


FIG. 3. Young chicken showing twisting of head associated with Newcastle disease.

SYMPTOMS OF NEWCASTLE DISEASE IN GROWING STOCK

The disease affects this group in much the same manner as the chicks. Respiratory symptoms may vary from flock to flock from very mild symptoms that may go unnoticed, to severe signs of respiratory distress. Nervous symptoms, as noted in chicks, may be absent. In some flocks, few birds will show characteristic involvement of the head or paralysis. The symptoms of Newcastle disease appear to be milder in the summer months and increase in severity in the winter months.

SYMPTOMS OF NEWCASTLE DISEASE IN LAYING BIRDS

In the laying flock, the disease affects the birds suddenly and the entire flock seems to become affected at once. The disease starts with difficult and noisy breathing, coughing, and sneezing. The birds are depressed and feed consumption goes down. They sit around on the floor and on roosts. The respiratory symptoms usually last in a flock for one to two weeks. Occasionally birds with nervous symptoms (twisting of the head or paralysis) are encountered but these symptoms may be completely absent.

Egg production drops abruptly and may go to zero within a few days after symptoms are noted. Soft-shelled eggs, eggs with no shells, and eggs with shell membranes are found. These malformed eggs may be found under the roosts, on the floor, and in the nests. The birds appear to have no control over where the egg may be laid. The color of the shell may change from white to brown or brown to white, depending on the breed. Under farm conditions about 20 per cent of the flocks will never return to their normal rate of laying. On an individual bird basis, it may be from two weeks to six weeks before a bird comes back into laying. On a flock basis it requires from one to two months for a flock to regain normal production, and in some instances the flocks never regain normal production. The influence on egg quality is considerable. Eggs with abnormal shells (thin shell, abnormal shape, small size) are consistently encountered after a flock has recovered egg production. Eggs are found with abnormal air cells, that is, the air

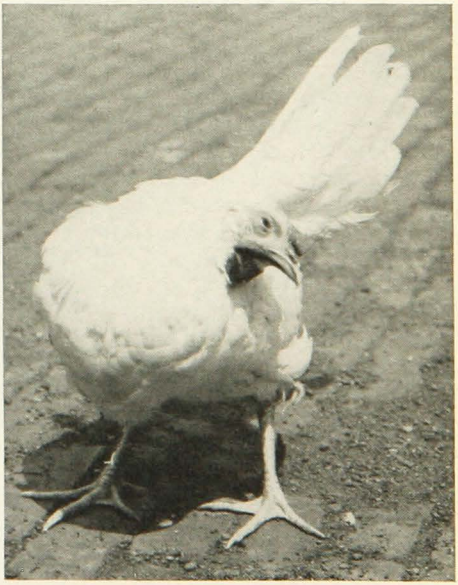


FIG. 4. Adult hen showing twisting of the head that is occasionally seen in a Newcastle disease infected flock.

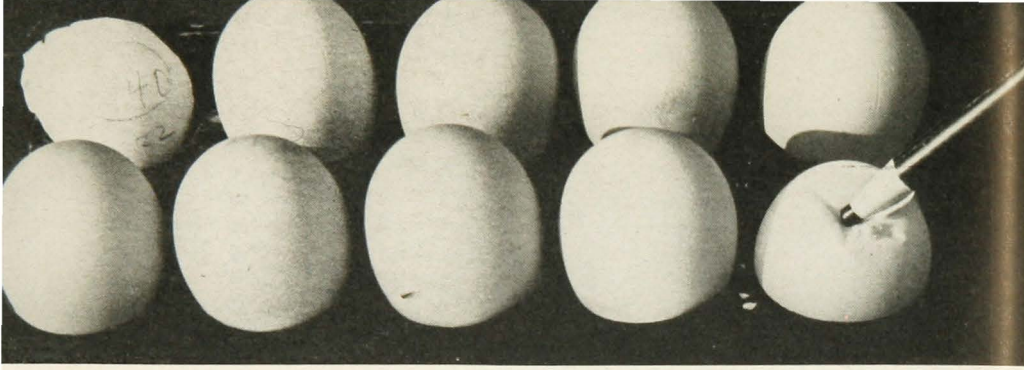


FIG. 5. Soft-shelled, malformed eggs are commonly encountered in laying flocks affected with Newcastle disease.

present in the egg occurs as free-floating bubbles. The albumen becomes watery; this quality may persist for several weeks. The yolks appear normal. Newcastle disease has a detrimental effect on the keeping quality of eggs in storage.

SYMPTOMS OF NEWCASTLE DISEASE IN TURKEYS

Newcastle disease occurs in turkeys of all ages.

1. Poults—The disease in young poults takes on the same form as in chicks; however, the symptoms are not as pronounced and may be easily missed. The respiratory phase appears to be mild and nervous symptoms (twisting of head and paralysis) are only occasionally encountered. The birds are depressed and feed consumption is decreased.

2. Growing stock—Because turkeys have more natural immunity to Newcastle disease than chickens, the disease in growing birds may go completely unnoticed. However, the disease in this age does produce depression, lack of appetite, and intestinal disturbances as manifested by loose droppings. Only rarely are birds encountered with nervous symptoms.

3. Laying flock—The disease can produce an adverse effect on a laying flock of turkeys. The disease has a more important economic effect because laying flocks are only held for poult production and if the disease hits during the egg laying period the loss in egg production is disastrous. The disease produces respiratory symptoms of difficult breathing such as gasping and coughing. Nervous symptoms are usually absent. The effect on egg quality usually is not as severe as in flocks of laying chickens.

4. Breeder flocks—In chicken- or turkey-breeder flocks that contact Newcastle disease during the period eggs are saved for hatching, the disease has a serious effect on hatchability and in most cases the flocks never regain good production to warrent their use as hatchery-supply flocks.

SYMPTOMS OF NEWCASTLE DISEASE IN OTHER POULTRY AND BIRDS

The symptoms of Newcastle disease in other fowl such as ducks, pheasants, guinea fowl, sparrows, and pigeons are similar to those which occur in chickens but are milder, less apparent, and may be overlooked unless laboratory studies are attempted.

FACTORS MODIFYING THE COURSE OF NEWCASTLE DISEASE

Certainly there are factors that play an important role in modifying the natural course of the disease. This

modification of Newcastle disease will become more apparent as the vaccination procedures become more widely used.

It has long been recognized that chicks or poults hatched from immune hens receive some degree of protection from the dam. This protection is often referred to as "passive immunity." The chick receives the passive immunity by the absorption of the Newcastle disease antibodies from the yolk sac. These antibodies may persist and give protection to the chick for as long as three weeks. Not all of the chicks from an immune flock will be protected for this interval or even for a week.

The symptoms of a natural outbreak of Newcastle disease may be modified in chicks by some degree of passive immunity. The respiratory symptoms may be very mild and nervous symptoms may be completely absent.

Birds vaccinated with one of the available vaccines (live-virus intranasal, wing-web, intramuscular, or killed virus) develop an active immunity. Active immunity means that the defenses in the body of the bird are stimulated to protect it against the virus of Newcastle disease when it enters the host. This protection is relative and not complete. Thus, the course of the natural infection in vaccinated birds is sometimes so modified that the characteristic symptoms of Newcastle disease are completely lacking yet the flock has gone through re-infection that can be determined only by laboratory studies. Birds from such a flock may act as carriers for a short period of time. The other important factor in the modification of the symptoms produced by Newcastle disease virus is the variation that occurs in the strains of the Newcastle disease virus. Some strains of the virus, in natural or experimental outbreaks, produce very mild respiratory symptoms and no nervous symptoms and therefore an outbreak may not be diagnosed as Newcastle disease.

Diagnosis

The symptoms as described under Natural Course of the Disease (page 10) closely resemble or are identical with those of a number of other infectious diseases. Bronchitis, laryngotracheitis, coryza, leukosis, mycosis, pullorum disease, and chronic respiratory disease (sinusitis) cause gasping and other respiratory signs indistinguishable from those seen in many Newcastle disease-infected flocks. The common nervous symptoms of Newcastle disease—lameness, paralysis, twisted necks — are much the same as those seen in cases of the following diseases: neurolymphomatosis (fowl paralysis), epidemic tremor, riboflavin deficiency (curled toe paralysis), vitamin E deficiency (encephalomalacia or crazy chick disease), and sometimes deficiencies of vitamin D (rickets) and vitamin A (starvation).

A distinction between Newcastle disease and bronchitis is particularly difficult in most flocks of growing and laying birds where the rather characteristic nervous symptoms of Newcastle disease are often absent. Even in broods of baby chicks nervous symptoms are not always seen or they may appear late in the disease, thus complicating or preventing an early diagnosis. The early sudden drop and cessation of production among layers and the development of nervous symptoms following initial respiratory symptoms in baby

chicks often suggest Newcastle disease.

The changes or lesions of Newcastle disease seen at postmortem examination differ greatly in location, severity, and extent from bird to bird and among flocks and outbreaks. The lesions, even in severe active infections, differ with age and are altered somewhat by partial immunity to the disease. The rapidly developing and acute cases may show prominent hemorrhages (bleeding) of the proventriculus (glandular stomach) and of the lymphoid patches and follicles of the intestine. Sometimes the heart and lung membranes of the body cavities are more or less hemorrhagic. In the acute forms of Newcastle disease the spleen may be mottled or quite pale and shrunken. The rather severe hemorrhages in the body tissue of some cases account for the paleness and small size of the spleen.

The similarity or identity of lesions as well as symptoms of Newcastle disease to those of a number of other diseases may not allow even the veterinarian or experienced pathologist to reach a final diagnosis. Hence, a diagnosis often requires laboratory assistance. The methods of recognizing the disease include: (1) isolation of the virus, (2) serum tests, and (3) histologic (microscopic) examination of suspected tissues.

Isolation of the virus: Birds in the incubative and early stages of the disease are usually necessary for this purpose. The most suitable specimens are those showing symptoms of impaired breathing during the first week of the infection in a brood or flock. After the flock has passed through the initial respiratory stage of the disease it is usually too late for virus isolation.

Tissues are collected from several birds. The spleen, lungs, and trachea contain the most virus and are therefore preferable to other tissues for virus isolation. The suspected tissues are ground in broth and inoculated into several fertile eggs that have previously been incubated for 10 to 12 days. After inoculation the eggs are further incubated. If Newcastle disease is present the virus will usually kill the embryos in 48 to 96 hours after inoculation. The dead embryos yield fluid for serum and other tests to identify the virus.

Virus neutralization tests: These tests are based on the fact that Newcastle disease causes the birds to develop antibodies which will neutralize or inactivate the Newcastle disease virus. Before setting up and reading a test it is important to know whether the flock has been vaccinated and, if so, when, since vaccination also causes antibodies to form and a positive test

FIG. 6. Diagnosis of Newcastle disease requires isolation of the virus from infected tissues. This is done by inoculating these tissues into embryonated chicken eggs.

FIG. 7. In the late stages of infection, Newcastle disease can be detected by the HI (hemagglutination-inhibition) test.

to persist for a considerable time. Tests with serum from a flock that has been infected or vaccinated as late as six to seven days previously will give a positive test. The serum of birds recovered from a natural attack often remains positive for a year or longer; vaccinated birds commonly show a weaker reaction and may become negative to the neutralization test within three to four weeks. It is well to remember that not all vaccinated or recovered birds develop a positive serum reaction and hence, 5 per cent, or in smaller flocks 10 per cent, of the birds should be sampled and tested to avoid errors in appraisal.

There are two methods or procedures for testing the serum for virus neutralization. They are:

1. **Test for virus neutralization with eggs:**

The serum of the test bird is mixed with an equal quantity of various tenfold dilutions of a known Newcastle disease virus. The mixtures are inoculated into embryonating eggs. If positive for antibodies, i.e., if the serum is from a bird that has been infected with or vaccinated against Newcastle disease, antibodies which are present prevent the virus from killing the embryo. Negative serum, i.e., that from a Newcastle disease susceptible bird, does not contain antibodies to neutralize the virus and thus, it kills the embryo. This test is reliable and permits diagnosis of Newcastle disease infection that has occurred as recently as one to two weeks, or, it determines earlier infection or vaccination.

2. **Test for virus neutralization in the test tube** (hemagglutination inhibition tests):

This test is not as dependable as the virus neutralization test with eggs but takes less time and is more economical of materials. It is based on the principle that Newcastle disease virus will agglutinate (clump) chicken red blood cells. The serum to be tested, either undiluted or diluted, is mixed with equal quantities of virus, which is constant strength or diluted, and a suspension of chicken red blood cells. If the serum contains Newcastle disease antibodies the virus will be neutralized and it will be unable to clump the red blood cells. In contrast, a negative serum, i.e., one without Newcastle disease antibodies, permits the virus to agglutinate the red blood cells.

What To Do in Case of Outbreak

GENERAL RECOMMENDATIONS

1. Prevent the disease from spreading to other flocks in the neighborhood. The flock should be isolated and visitors should not be allowed near the flock. Poultry equipment must not be removed from the farm unless cleaned and disinfected. The flock should not be marketed while in the acute respiratory stage of the disease since this could endanger many flocks and contaminate the produce plant.

2. Obtain a diagnosis of the problem. This can be done by contacting the local veterinarian or the state veterinary diagnostic laboratory. Live, sick birds showing various symptoms should not be sent by common carrier but brought to the laboratory.

RECOMMENDATIONS FOR THE HATCHERY

If a hatchery is the source of Newcastle disease infected chicks, the disease will be found existing in the battery room where started chicks are being brooded. Newcastle disease is rarely encountered in chicks obtained from a hatchery selling day-old chicks only.

How is Newcastle disease virus introduced into a hatchery? There are several possible means:

1. Operation of a dressing plant in conjunction with a hatchery.
2. Obtaining hatching eggs or market eggs from a flock in the active stages of the disease.
3. Introduction of chicks from outside source that may have been exposed to Newcastle disease virus in transit or at the point of origin.
4. Reuse of chick boxes.
5. Sick poultry brough to the hatchery for diagnosis.
6. Visitors handling chicks in the battery room.

Newcastle disease can be eliminated from the hatchery by completely depopulating the battery rooms, cleaning and disinfecting equipment, and fumigating the rooms with formaldehyde. The hatchery probably can continue to operate if only day-old chicks are sold during the clean-up period, otherwise, it may be necessary to stop all hatchery operations.

RECOMMENDATIONS FOR THE FARM

Baby Chick Flocks

The most serious outbreaks of Newcastle disease are encountered in chicks under four to six weeks of age. When Newcastle disease occurs in a group of chicks, it may be advisable to destroy the flock.

There is no specific treatment except to maintain adequate brooder house temperature and encourage the chicks to eat and drink. The use of sprays and inhalants have little influence on the course of the disease in a flock.

If the flock is destroyed, clean and disinfect the brooder house; it may be restocked again within a few weeks. Otherwise clean and disinfect the house after the flock has recovered.

Take care to avoid spreading the disease to other susceptible poultry on the farm. In many instances the owner carries the infection to the laying flock before he realizes the chicks are affected with Newcastle disease.

Growing Flocks

When Newcastle disease affects birds older than six weeks of age, the actual loss in these birds is not as serious as

in baby chicks but the loss in weight and condition is considerable. Give the birds adequate housing or shelter to protect them from weather. Encourage feed and water consumption.

Laying Flocks

Again, as in the case of chicks and growing birds, the laying flock needs care to encourage feed and water consumption. There is no specific treatment for a flock in the active stages of the disease.

In some cases it would be desirable to market the flock after it has recovered; whereas, in young pullets just beginning their laying year, it may be advantageous to keep them for egg production. Isolate replacement chicks if they are brought to the premises before the recovered birds are marketed.

The Broiler Plant

In the broiler plant that adds successive lots of chicks at weekly or biweekly intervals, it is very difficult to stop an outbreak of Newcastle disease. The only successful method is to stop adding new lots of chicks until the plant is depopulated and can be cleaned up and disinfected. The use of any one of the available vaccines will not give satisfactory results because a period of 7 to 14 days is needed before resistance is acquired. If chicks from the infected plant can be placed in isolation for at least two weeks to allow immunity to develop from the vaccination, the cycle of infection may be broken and it may not be necessary to stop production.

After the plant has been depopulated, clean and disinfect the batteries. For cleaning, use a hot lye solution—1 pound of lye to 15 gallons of water. To disinfect the equipment, use an approved cresol disinfectant or quatenary ammonium compound. Wash down the walls and ceilings and then fumigate the rooms with triple strength formalin, 3 ounces formalin and 1.5 ounces of potassium permanganate per 100 cubic feet for 24 hours. Have as much moisture present as possible during fumigation. Leave the plant vacant for one to two weeks before restocking. It is best to buy only day-old chicks from a local source since they are less likely to have been exposed to Newcastle disease than chicks shipped from an outside source by common carrier.

If Newcastle disease is encountered in the broiler operation where only one age group is brooded at any one time, clean and disinfect the house thoroughly. If deep litter has been used, remove it and start new deep litter, If the house can be left empty for one to two weeks before restocking, you will be more certain that the Newcastle disease virus was killed.

Prevention

PREVENTION BY SANITARY MANAGEMENT

Hatchery

Every precaution must be taken to avoid the introduction of Newcastle disease into a hatchery. The following are important safeguards:

1. Isolate the hatchery from broiler plant and dressing plant.
2. Use separate labor for the started chick brooding plant.
3. Brood started chicks and surplus

chicks in another building away from the hatchery.

4. Sell day-old chicks rather than started chicks.

5. Obtain weekly reports from flock owner and keep a close watch on egg records for any drop in egg production in supply flocks.

6. Do not have used feed sacks or chick boxes returned to the hatchery.

7. Dispose of hatchery wastes properly.

8. Discourage visitors and other traffic into the hatching and brooding rooms.

9. Change wearing apparel before entering the chick room.

Farm Flocks

To safeguard the farm flocks against Newcastle disease, practice these essential rules:

1. Isolate the farm flock from visitors. The poultryman should be careful about going to neighboring flocks and should he do so, his outer clothing should be changed and shoes and boots disinfected before tending his own flock.

2. Buy only day-old chicks from a reliable local hatchery. Started chicks have a greater chance to be exposed to Newcastle disease or other respiratory diseases and consequently, you may be buying a disease with the started chicks. Rear the replacement flock away from the adult birds on clean range not only to lessen the danger of transmission of Newcastle disease from old birds, but also avian leucosis, infectious bronchitis, fowl cholera, and other respiratory diseases.

3. Use precautions in marketing birds. It is a common practice to sell the culls to poultry buyers. These poultry buyers and their crates, etc., should be restricted from the house in order to prevent the introduction of Newcastle disease and other contagious diseases into the flock. It would be safer to crate your own birds and take them to the produce plant. Clean and disinfect the crates before returning them to the farm.

4. Maintain all pullet flocks. For the average poultry farm it is best to market the flock at the end of the laying season so that old birds are not mixed with the pullet flock because there is the danger that they may be carriers of Newcastle disease or some other respiratory infection.

5. Remove manure to fields that will not be used for poultry. Storage pits or sheds are often indispensable.

6. Use a burial pit, incinerator, or deep burying to dispose of dead birds. Don't feed dead birds to the hogs or leave them lying around the yard.

7. Have your own chicken crates to be used only in your flock. If crates are used away from the farm, clean and disinfect them thoroughly and allow them to dry in the sun for several days before storing them.

8. Replace the litter after an outbreak of infectious or parasitic disease.

9. Clean and disinfect feed bags thoroughly if they are to be returned for reuse.

10. Clean and disinfect the laying house thoroughly after it has been depopulated of chickens. Use lye and an approved disinfectant. Treat the roosts with mite paint. After the brooder house and range shelters have been vacated, clean and disinfect them for the next season's brood.

11. Control rodents and wild birds. Rats, mice, and free-flying birds may spread a number of poultry diseases such as Newcastle disease.

Broiler Plant

The observation of strict sanitary practices as outlined above is the key to successful broiler operation. Immature birds, birds for slaughter, or birds for visceration from an outside source,

should not be introduced into the broiler plant.

Produce Plant

Sometimes chickens or turkeys in the active stages of Newcastle disease are marketed. These birds may infect other birds in the feeding station, and the produce plant may serve as a source of infection to the neighboring hatchery, broiler plant, and poultry farms.

One of the principal means of spread is contaminated poultry crates. The poultry crates should be so constructed and handled that they can be easily cleaned and disinfected after daily use.

It is the duty of the operator of the produce plant to take all precautions to avoid the spread of Newcastle disease and other infections by means of produce crates, egg cases, and contaminated wearing apparel and footwear of his employees.

Feed Manufacturer and Dealer (Mill and Store)

The feed manufacturer and dealer can be of considerable aid in preventing the spread of Newcastle disease by encouraging stricter application of the principles of good management and sanitation. Avoid the reuse of feed sacks, unless properly cleaned and sterilized, as they may be a means of spreading Newcastle disease. Poultry servicemen and other representatives of feed companies in their visits from farm to farm must take all the necessary precautions to avoid carrying infective material on their footwear and wearing apparel.

The Veterinarian

The veterinarian can play an important role in advising the poultry farmer on disease control and sanitation problems. The first line of defense against further inroads of serious poultry problems such as Newcastle disease is an early recognition and application of effective sanitary measures.

PREVENTION BY VACCINATION

Vaccination, properly and judiciously employed, is a valuable supplement to a basic, sound, long-range program of sanitary management for the prevention and eradication of Newcastle disease.

A major limitation of vaccination as applied to the control of Newcastle disease and several other highly contagious diseases is that the poultryman frequently depends too much upon it. Often, vaccination is substituted entirely for the necessary sanitation and management measures without which serious difficulty and disappointment commonly ensue.

Finally, the degree of risk that a brood or flock may be exposed to Newcastle disease should decide whether vaccination is necessary or desirable. Farm flocks at a considerable distance from other flocks and centers of infection are least likely to become exposed. Such flocks and premises are not often visited by poultry buyers, salesmen, and others that may have come from diseased flocks and areas. The chances of exposure of such flocks by contaminated feed bags, crates, and trucks is usually appreciably less than to flocks, hatcheries, and plants in localities where the flocks and establishments are closer together and the poultry population larger.

A basic limitation of vaccination as a Newcastle disease control measure and as a substitute for control by sanitation is seen in the cost of an adequate vaccination program for the entire country. Vaccination of breeding and farm flocks, exclusive of a billion broiler birds, would entail vaccination of an estimated 300 million to 400 million chickens each year.

Vaccination against Newcastle disease, pox, and laryngotracheitis requires separate vaccines usually given at different times. With each additional vaccine the cost of vaccination per bird is increased several cents.

Finally, the problem of vaccination may be not only one of time, labor, and spacing between the several operations, but a question as to whether the bird can respond properly to the constantly increasing number of vaccines.

Eventually, the decision whether vaccination is or is not to be practiced must constitute a calculated risk against: (1) the possibility of exposure to Newcastle disease, and (2) an unsatisfactory response to vaccination.

Vaccination may not result in a substantial immunity if the flock is suffering from other diseases or devitalizing influences. The reaction to living vaccines may be unduly marked or severe.

In spite of the most careful standardization of the vaccine, the circumstances of its use, the environment of the flock, and the health status and response of the birds and flocks into which it is introduced differ very greatly and can never be standardized. Hence, the results may be variable and disappointing and the need for major dependence on a basic and realistic sanitary management program of disease prevention is more apparent.

Two Types of Vaccine

Two general types of Newcastle disease vaccine, the killed virus and the living virus, are available:

Killed Virus Vaccine. Killed Newcastle disease virus vaccines are prepared by growing suitable strains of virus in embryonating eggs, harvesting the dead or dying embryos and tissues, and inactivating the virus with formaldehyde or ultraviolet light. Substances such as alumina gel are sometimes added to increase and prolong the immunizing effect. The vaccines must be tested for safety and potency and be given a "use expiration" date before release.

Each ½ to 1 milliliter dose of the vaccine contains a large quantity of killed virus, the reaction to which governs directly the degree and duration of the immunity which the bird can develop. Usually this immunity is not as strong or durable as that from live virus vaccination, which, to be effective, must actually produce an attack of Newcastle disease.

Killed Newcastle disease vaccine affords protection by a blocking effect within a week after injection. Specific immunity against Newcastle disease develops within a week after vaccination and it is well advanced at two weeks in healthy birds six weeks of age or older. The immunity may wane considerably during the period of two to six months after vaccination. Revaccination at two weeks to several months strengthens and prolongs the immunity and the ability to respond more quickly and effectively to later Newcastle disease exposure.

Living Virus Vaccine.[2] Living Newcastle disease virus vaccines are prepared by growing, on embryonating eggs, single modified or "weakened" strains of Newcastle disease virus. Great care is required to keep the vaccine virus at a satisfactory stage of modification and to avoid contamination with other viruses and bacteria. The infected embryo material is dried to powder from the frozen state. Further refrigeration before it is used and proper care during its use are required to keep the vaccine virus alive and capable of producing satisfactory results.

The living Newcastle disease vaccines now available from commercial sources are administered by different routes, namely the "stick" or skin and the "drop" or intranasal and the intramuscular. Other routes include drop-

[2] Certain states restrict the use of live virus vaccines.

ping the vaccine into the eye or spraying or atomizing the vaccine for inhalation.

The modified virus employed in the "stick" method vaccine usually produces a mild form of Newcastle disease with a large majority of healthy birds of four to six weeks of age or older. Given by other routes, e.g., intranasally or intramuscularly, it may cause rather severe shock or fatal infection, especially in young chicks or devitalized birds of any age.

The virus employed in the intranasal method vaccine is adapted to growth in the respiratory tract and to stimulate a moderate degree of immunity in a large majority of healthy birds. While its use has been advised in baby chicks and laying flocks, the systemic reaction in some cases has been so severe as to impair production appreciably and to contribute heavily to chick mortality.

Because of the relatively small quantity of virus introduced with the living Newcastle disease vaccines, the blocking effect is seldom as substantial as it is with the killed Newcastle disease vaccines. The specific immunity engendered by living vaccine infection should appear within a week after vaccination and should be of substantial degree after the second week. The immunity from living vaccine begins to wane within 2½ months and proper revaccination is usually recommended within two months to a year.

That neither the killed nor living vaccines have given fully satisfactory results is apparent from the continuing efforts to improve them. While the killed vaccines can be used in birds of any age or status of production or health, the immunity produced by them has not been as strong or durable as desired. Nevertheless, vacination of baby chicks, or those less than six weeks of age, may not be expected to give a maximum immunity to a satisfactory proportion of the brood or lot. Likewise, use of killed vaccine in birds of low vitality may fail to produce a satisfactory degree of immunity although the health is not further impaired, as may be the case with live virus vaccination.

While a stronger and more lasting immunity usually may be expected with the living than with the killed Newcastle disease vaccine, these advantages of the living vaccine are often offset by a relatively severe vaccination-disease reaction even in broods and flocks of suitable age and production status that appear to be in normal health when vaccinated. The use of living vaccines may also present the problem of introducing Newcastle disease infection into previously clean flocks and areas. The possibilities that the vaccine virus may become fully active and destructive are not great but cannot be overlooked.

Another factor that may alter the response to vaccination is the immunity the hen that has had Newcastle disease or has been vaccinated against it transmits to her chicks. Where the hen's immunity is of high grade, the chick will carry a yolk-borne immunity up to 30 days of age. If the hen has a partial immunity the passive immunity of the chicks may be lost at two weeks or earlier. The immunity gives the chicks a degree of protection against natural infection and also prevents a "take" or immunity from vaccination. Failure to recognize the influence of the previous Newcastle disease status of the breeding flock and the degree of immunity which the chick or flock may carry at any time may lead to apparent failure of vaccination.

Obviously the indiscriminate, careless, and improper use of vaccines will result in difficulty, confusion, and loss. Only when vaccination is praticed as a supplement to a long-range sanitation program of a community, state, and national scope can it be fully effective.

Future Goals and Objectives

The final goal or objective of a sound disease-control program is eradication of the disease. The older as well as the newer methods and information, however, must be accepted and applied on a large and comprehensive scale if a well-established disease is to be eradicated. Authorities on disease recognize that education toward the means, necessity, and economy of stamping out a disease are at least of equal importance to the research and investigation required to develop newer and more effective methods of combatting such a malady.

The simplest and most logical control measure against infectious diseases like Newcastle is to prevent contact of the infectious agent or virus with the susceptible bird or animal. A second and indirect method, applicable against some diseases, is vaccination. The latter gives the animal a degree of protection against the infection in case of exposure. The third, and generally least satisfactory and least economical procedure, is to treat the animal after it is exposed or has become affected.

A combination of the first two methods may be required at the outset for a highly contagious disease such as Newcastle that has become widespread in a community, region, or country. However, both phases must be carried out on a sufficiently thorough and wide basis. At least 70 per cent of the flocks in an area must be included in the rigid sanitary program along with a satisfactory twice-a-year vaccination program.

Compliance with the sanitary program often prevents Newcastle disease where the poultry population is relatively small and the flocks are some distance apart. Vaccination may be required as a supporting measure of sanitation and, if so, it should be so employed as a weapon towards eradication. If it is not used properly and wisely, vaccination will continue to be a considerable year-after-year expense.

Effective treatments against Newcastle disease and many other diseases have not been developed. Furthermore, no matter how effective possible "miracle drugs" of the future may be against Newcastle disease, the "remedy" cost must be added to the toll already taken by disease before treatment can be instituted.

The effectiveness of the sanitation program is limited only by the extent of participation by all those concerned with the poultry industry. Organization at the community level usually depends upon the foresight and enthusiasm of one or more forward-looking individuals. The interest and effort of others can be enlisted readily.

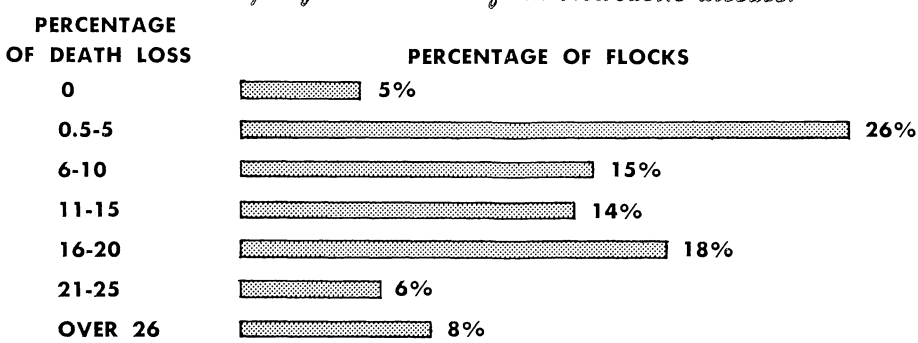
The local county agent and veterinarian, agricultural extension service, representatives of state and federal agencies, as well as poultry, hatchery, dealer, and other organizations can be counted upon to aid in expanding and strengthening the sanitary program. At the outset, 75 per cent of the farmers or poultrymen in an area will participate. The remainder may require further contact, urging, or even pressure.

The effort towards developing and applying a sound, long-range sanitary program is now, more than ever before, necessary to protect the future of our poultry industry against the inroads of Newcastle disease and a host of other infectious and parasitic diseases.

EFFECT OF NEWCASTLE DISEASE ON LAYING HENS

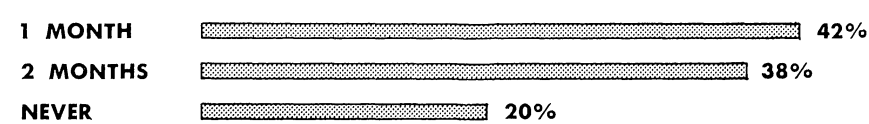
(The results of a survey of what happened in 100 farm flocks affected with Newcastle disease)

What was the range of death losses from Newcastle disease?

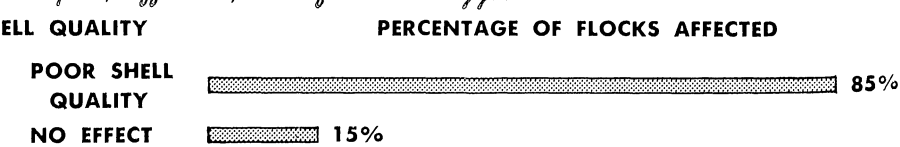


What effect did Newcastle disease have on egg production?

How long did it take a flock to regain normal egg production?



What effect did the disease have on shell quality such as misshapen, off-color, or soft-shelled eggs?



The survey reported here was conducted in Minnesota during 1949-50 by the School of Veterinary Medicine, University of Minnesota.