Evolution of Avian Pathology in Europe during the past 50 Years

Abstract
With the development of the modern poultry industry, several poultry diseases spread due to vertical transmission and caused high mortality. Mycoplasma gallisepticum (Mg), a trigger of E. Coli, caused substantial losses on broiler farms. Pullorum and Leucosis virus types A in layers and type J in broilers had to be eradicated from breeding stock to stop vertical transmission. New diseases spread during the last decades. In 1969, Biggs identified the cause of the tumor form of Marek’s Disease and, together with Witter, developed vaccines based on attenuated Marek herpes virus (Biggs) and turkey herpes virus FC 126 (Witter). The CVI 988 (Rispens) virus has been used since 40 years and is still effective. V. Bulow and Vielitz identified the chicken anemia virus in 1983 as the cause of anemia in broiler flocks. EDS virus and other types of adenovirus were identified as causes of mortality and depressed production and egg quality. Vaccines to control Salmonella infections with S. typhimurium and S. enteritidis were developed and are widely used to reduce the risk of food poisoning. The re-introduction of free range management and the ban on effective drugs to control diseases like Histomoniasis and necrotic enteritis brings us back to disease problems of the 1960s.

Keywords
poultry diseases, Newcastle, FowlPox, AE, IB, Marek’s, Leukosis, Gumboro, CAV, Salmonella, ectoparasites, free range management, Avian Influenza

Introduction
The evolution of avian pathobiology during the past five decades is closely linked to two major developments in global poultry production:

1. Genetic selection of meat-type and egg-type chickens and other poultry species
2. Development of housing and management for efficient production of poultry meat and eggs in large units

Nowadays commercial white egg and brown egg layers produce more than 300 eggs per year and consume about 120 g of feed per egg, roughly 50% less than 30 years ago. Total egg mass per hen often exceeds 20 kg per year, ten times the hen’s body weight. Similarly, meat type chickens are reaching market weight much earlier and on less feed than 30 years ago, in Germany e.g. 2 kg live weight at 35 days of age on less than 1.6 kg feed per kg gain. Before specialized meat-type and egg-type chickens were imported from North America in the 1960s, laying hens laid about 120-150 eggs per year, and it took cockerels 4 months to reach 1 kg live weight as "bri- lers". The first imports from North America produced almost twice the number of eggs or grew twice as fast, with corresponding savings in feed cost.

Free range management, common in the 1950s, was associated with high mortality rates from predators and numerous parasitic and bacterial infections.

Straight from the university - challenged to solve industry problems
While studying veterinary medicine, my knowledge of chicken diseases was limited to pullorum disease, coccidiosis and Marek's Disease. When I started to work for Herrn Lohmann in 1959, the first practical lesson to learn was that birds in free range farms had to be caught from trees for poux vaccination!

To prevent high mortality due to free range management, environment controlled chicken houses were built in the 1950s, and the production of poultry meat and eggs became a full-year business focused on utilization of facilities. As a result, mortality was lower, weight gain and feed efficiency improved.

To benefit from advancements in poultry science in North America during WW II, Lohmann had signed agreements with two American primary businesses. Nichols (1956) and Heisdorf & Nelson (1958) to breed and distribute broilers and laying hens, respectively, in Germany and subsequently in Europe and worldwide. With these contracts, American know-how in applied poultry science was also imported.

Newcastle Disease (ND)
In 1960 we had the first severe outbreaks of ND in Germany, with 30-40% mortality in broiler flocks. Only vaccinated ND vac- cines existed in Germany in those days, requiring individual injection. We learned of a live Newcastle virus vaccine in the United States, based on the Hittcher 81 lentogenic virus that could be adminis- tered in the drinking water. Importing and applying this vaccine soon brought the disease under control. As a result of these experiences we became convinced that only live vaccines are powerful enough to protect the birds sufficiently.

Fowl Pox
In the early 1960s fowl poux disease was also detected in Germany. At that time a live vaccine of the Behringwerke based on an attenuated fowl poux virus strain proved to be very successful and the disease dis- appeared for a long time. Unfortunately the awareness of fowl poux risks also vani- shed and live vaccination against fowl poux was eliminated from the vaccination sche- dule for many years. The disease appeared again in 1999, with more than 60 flocks affected in Germany, and live poux vaccina- tion was re-introduced successfully.

Avian Encephalomyelitis (AE)
In the early 1960s breeding stock of layers and broilers were generally kept in well isolated houses with best possible hygie- nic conditions. These flocks remained free of a number of natural infections during rearing. However these infections could be introduced during hatching egg produc- tion, after the birds were transferred to lay- ing houses. This resulted in 1961 in the first epidemic disease in unprotected broiler progeny. The chicks showed paralysis and tremor, and the condition was diagnosed as avian encephalomyelitis (AE), also called epidemic tremor. This is a viral infection, transferred vertically from the mother via the hatchingegg to the offspring.

Since American poultry consultants like Dr Donald Zander (H Sinn-Laboratory, USA) had already had experience with this dis- ease, diagnostics and preventive treat- ment were quickly introduced. Parent birds were prevented from shedding the AE-virus before they started to produce hatching eggs. Brains of symptomatic chickens were homogenized and adminis- tered to the parent birds via the drinking water during rearing. This was the first au- tonomous vaccine we produced!

Feed related diseases: en- cephalomalacia and fatty liver syndrome
Feed born encephalomalacia due to in- sufficient supply of vitamin E and anti- oxidants was diagnosed as a major prob- lem in broilers. This condition disappeared when the feed formulation was corrected. Another real problem was the fatty liver syndrome, typically found in high produc- ting caged laying hens. In collaboration with Prof. Köhler (10) from the pathology institute in Vienna we were able to identify feed composition as a major cause. The incidence was substantially reduced by replacing carbohydrates by fat (un- saturated fatty acids) in feed formulation.

Infectious bronchitis (IB)
With the introduction of laying cages in the early 1960s the stocking density per unit and the general bird density in certain regions also increased. This ap- parently contributed to more and more cases of IB in laying hens shortly after the AE-epidemic was solved. A large number of vaccination trials were carried out between 1963 and 1964, using attenuated
Marek’s Disease (MD)

In the course of the 1960s a new form of Marek’s disease occurred in southern Europe. Until then we had known only the classical form causing paralysis and ricketyosis. With the new form the birds developed tumours in organs, and mortality was extremely high. In Spain up to 100% of the chickens died. As a consequence a number of chicken breeders intensified resistance breeding. Geneticists of H&N and Lohmann decided to split the birds and selected parallel lines (i) only for conventional traits, (ii) only for MD resistance and (iii) on an index with similar emphasis on conventional traits, (ii) only for MD resistance and (iii) on an index with similar emphasis on egg production and MD resistance. The results of cumulative genetic progress after 5 years were published in 1974 by Roos et al. (8) and showed a reduction of MD severity by 20% in the MD selected sub-lines vs. 2 kg increased egg mass in the main line. The competition between geneticists and veterinarians to control this disease was decided when the virus was identified as herpesvirus by Dr Biggs in 1969 and Dr Wittler in 1970. Dr Biggs also found the HVT strain in turkeys to be non-virulent and protective against Marek’s Disease in chickens. The first European HVT vaccine against Marek’s Disease was introduced into Spain in 1971 (1, 20, 35). In the Netherlands Dr Bart Rispens used a non-pathogenic Marek herpesvirus he had isolated from chickens, as a vaccine strain. He called this virus CVI 198 (Central Veterinary Institute). At that time we in Germany were satisfied with the HV1 based vaccine (22, 23).

At the end of the 1970s in southern Europe and North Africa the first cases of Marek’s Disease were claimed despite HV1 vaccination. Especially in Egypt this resulted in great losses. It was striking that the bird shipments from Holland did not develop the disease. These birds had been vaccinated with the Rispens strain CVI 198 in the Dutch hatcheries. We quickly switched from HV1 to the Rispens vaccine and thus solved the problem (5, 8, 9, 11, 17, 22, 23, 25, 27, 29).

Gumboro and Egg Drop Syndrome (EDS) and IBD

In 1967, the first cases of Gumboro disease occurred in white layers in Germany, characterized by low mortality rates (18). In 1976, in The Netherlands, a new disease called Egg drop syndrome (EDS) occurred, the cause of which was a Dutch adenovirus. This virus was introduced through contamination of duck fibroblast cultures used in Marek vaccine production in The Netherlands. The Lohmann vaccine remained free from it because the vaccine was prepared in primary SPF chicken embryo fibroblast cultures.

In the late 1970s Prof. Becht and his research student Mrs. Curseifen from the University of Giessen described a mutant of the virulent Gumboro strain Cu-1M. The virus was a mini-plate variant and as such was non-pathogenic but very invasive. In 1978 Lohmann developed a live Gumboro vaccine using this virus strain Cu-IM (8, 7).

In the early 1980s layer flocks suffered from losses of up to 70% caused by so called v-IBD. These field strains can break through much higher maternal antibody levels than so called intermediate Gumboro vaccines. Therefore it became necessary to vaccinate birds earlier with stronger live IBD vaccines (28).

Mycoplasmosis (MG and MS)

Ever since I worked with poultry, avian mycoplasmosis was an issue. Especially in the presence of management stress or other respiratory pathogens, broilers showed depressed weight gain and layers a significant drop in egg production due to Mycoplasma gallisepticum. Subclinical Coli infections caused heavy losses. Therefore the permanent aim of the global poultry industry was the eradication of this microorganism. Well managed farms were completely depopulated, extremely thoroughly cleaned and disinfected before new birds were placed. To remove the mycoplasmas from the hatching eggs, tylosin was injected on the 9th day of incubation. This enabled us to eradicate MG infections from our broiler breeders in 1966/67 (16). In contrast, our layer breeders were infected with tylosin-resistant MG. These Mycoplasms were non-pathogenic, but the birds became serologically positive. The eradication succeeded later by in-ovo injection of Baytril. Mycoplasma synoviae (MS) is a very contagious microorganism and is still found in many farms. For a long time we could not verify any pathogenicity, but more recent evidence indicates that MS is responsible for low egg shell quality (‘apex’) and respiratory problems.

Laryngotracheitis (ILT)

Laryngotracheitis (ILT) first occurred in Germany in 1977 in LSL layers from different parent flocks. The eradication of ALV from primary breeder stocks was an essential prerequisite for the introduction of feather-sexing White Leghorn crosses. The disease almost disappeared in commercial layers. Leukosis became important once more in broiler breeders in the early 1990s. The virus strain was eradicated within two years.

Inclusion body hepatitis (IBH) and hydropericardium

In 1987 progeny of broiler breeders suffered from high losses due to inclusion body hepatitis (IBH) and hydropericardium. At the same time a similar outbreak of the same disease was observed in Pakistan, which was called Angara Disease. As a causative agent an Adeno virus could be isolated from infected progeny. Again the progeny was protected, when parent birds had seroconverted before beginning of lay. The disease was transmitted vertically. Therefore the Adeno virus was eradicated and a live vaccine was administered to the next parent bird generation during rearing via the drinking water.

Salmonella

In 1989 the British Minister of Health Edwina Currie declared “We do warn people, that most of the egg products in this country, sadly, is now infected with Salmo- nella.” Also in Germany it was a big threat to the poultry industry in the 1990s when Salmonella infections of poultry resulted in Salmonella outbreaks in man. The causative organism contributed significantly to the fact that entries of commercial LS layers from different parent flocks averaged more than 300 eggs per hen housed to 500 days of age in German random sample tests. The eradication of ALV from primary breeder stocks was an essential prerequisite for the introduction of feather-sexing White Leghorn crosses. The disease almost disappeared in commercial layers. Leukosis became important once more in broiler breeders in the early 1990s. The virus strain was eradicated within two years.

Leukosis

In the late 1970s we intensified the screen- ing of all egg lines at the pedigree level to eliminate all virus infections. This eradica- tion apparently contributed significant- ly to the fact that entries of commercial LS layers from different parent flocks averaged more than 300 eggs per hen housed to 500 days of age in German random sample tests. The eradication of ALV from primary breeder stocks was an essential prerequisite for the introduction of feather-sexing White Leghorn crosses. The disease almost disappeared in commercial layers. Leukosis became important once more in broiler breeders in the early 1990s. The virus strain was eradica- ted within two years.
Ectoparasites: Red mites and black beetles

In the 1990s, red mites (Dermanyssus gallinae) became an increasing problem, especially among densely housed layers. Reduced egg production, nervousness of flocks, and increasing mortality, up to 30%, were the consequences. This problem is unsolved until today. Cleaning, thorough washing and the application of pesticides is only a temporary solution. Intensively housed broilers on the other hand can be accompanied with black beetles (Alphitobius diaperinus), that appear in millions in the litter. Both ectoparasites can harbour a number of different bacterial and viral infectious agents. The parasites and with them a number of diseases spread from flock to flock.

Free range management

Despite the negative experience with free range management in the late 1950s, free range housing was introduced again in the 1990s. Advantages and disadvantages of different housing conditions of layers are compared in the following table.

As shown in this summary, cage management is preferred in terms of health and product quality, but does not meet animal welfare demands and has therefore been banned in some countries. Floor husbandry provides better conditions in terms of bird welfare, but at the expense of product quality and animal health.

Bacterial infections and autogenous vaccines

Many bacterial infections such as E. coli, Pasteurella and Erysipelothrix re-occurred under free range conditions. Also Ornithobacterium rhinotracheale as a respiratory disease agent and parasites such as Histomoniasis have been detected. Among these bacteria a number of isolates have been found that cannot be typed by conventional methods. Therefore no registered vaccines are on the market and autogenous inactivated vaccines currently fill these gaps.

Autogenous vaccines are also increasingly used since the overuse or misuse of antibiotics has been linked to the emergence and spread of antibiotic resistant micro-organisms. Their treatment is ineffective, and they pose a serious risk to public and animal health. Autogenous vaccines have become a real alternative to antibiotics. Well known examples of antimicrobial resistant micro-organisms among the chicken population are multi-resistant Staphylococcus aureus and E. coli.

Regarding the use of antibiotics in livestock the old paradigm is still applied today. “If the microbes are exposed over time to a suboptimal concentration of antibiotics they defend themselves by developing resistance. Therefore attack bacteria with a high dose of antibiotics over a short time” However this is questioned today, since it only seems to be true in vitro, but not in vivo. In-vivo it may well be just the other way round. In the animal, low doses over a long period of time allow the healthy flora to develop again, which it doesn’t do under high antibiotic concentrations.

Avian influenza (AI)

The first description of avian influenza dates back to 1878 by Peroncito in northern Italy. Highly pathogenic avian influenza (AI) virus known as H5N1 was discovered in 1997 on a goose farm in China. Since 1997 H5N1 has spread to over 40 countries in Asia, Africa and Europe. Severe outbreaks occurred in the beginning of the new millennium in Italy, then in the Netherlands and Germany. The virus is endemic in wild water fowl and can spread to domestic birds.

In the case of low pathogenic strains such as H9N2 birds only shed the virus without any clinical symptoms. The virus can even spread to humans or other mammals. Highly pathogenic AI viruses are a permanent threat to the poultry industry, because in case of outbreaks the whole flock is killed (stampeding out policy in the EU). In Europe vaccination against highly pathogenic AI viruses (H5, H7) is banned. A number of research projects based on genetically modified live AI-viruses failed due to the very frequent genetic shift and drift of the virus. At the moment the vaccinated industry has declared the inactivated AI vaccine to be the gold standard against the disease.

Outlook

During past decades, general hygiene, biosecurity and vaccinations contributed to a significant reduction of mortality from a range of poultry diseases. Adapted to local disease risks, these principles remain essential for disease control. The methods will be further refined, and the Veterinary Laboratory of Lohmann Tierzucht will continue to play a significant role in the application and promotion of new knowledge.

References

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References

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NOTES