Broiler Industry Strategies for Control of Respiratory and Enteric Diseases

M. A. DEKICH[1]

Fakieh Poultry Farms, Taif, Saudi Arabia

ABSTRACT The commercial broiler industry is a modern day agricultural success due to popular consumer demand, healthy flocks, and least cost production. Preventive medicine is the key for economical control of disease in integrated broiler companies, and includes quarantine-eradication, controlled-exposure, and preventive feed medication. Respiratory and enteric diseases present a continuing, potential threat for economic loss. Most exotic and egg-transmitted poultry diseases have been controlled by reduction or eradication policies. Endemic diseases are controlled by mass vaccination and preventive feed medication. Improvements in genetics, housing, equipment, and disease surveillance has allowed continued improvements in disease prevention. Attention to detail and management of risk is crucial to industry success. With fast industry growth and market maturity of the broiler industry, new challenges have risen. These challenges include increased poultry house density, increasing economic pressures, changing industry attitudes, and increased governmental regulations that will strain the continued success of today's control strategies.

(*Key words*: broiler, respiratory disease, enteric disease, preventive medicine, vaccination)

1998 Poultry Science 77:1176–1180

INTRODUCTION

The commercial broiler industry continues to grow as domestic consumption and export opportunities increase. Least cost production has resulted in profits leading to expansion of the industry. Continuous genetic selection has resulted in fast growth, better feed conversion, and high meat yield on an annual basis. Utilization of maximal genetic potential in live production performance has been paramount for least cost production and disease control is critical for best live production performance. Current disease control strategies for respiratory and enteric diseases have been largely successful to data. Preventive medicine is the basis of these strategies.

Preventive medical strategies are quarantine-eradication, controlled-exposure, and preventive feed medication. The most valuable poultry stock, primary breeders, are to a large extent raised in geographic isolation from the major broiler producing areas in the U.S. Disease exposure is further minimized with maximum biosecurity that includes physical barriers to farm entry, shower in/out facilities, and permanent, on farm work forces. The most severe respiratory diseases, such as highly pathogenic avian influenza (HPAI), velogenic viscerotropic Newcastle disease (VVND), and velogenic neurotropic Newcastle disease (VNND), are exotic to the U.S. and have been controlled by eradication policies in cooperation with USDA. Historically, the broiler industry has eliminated or reduced various economically significant diseases through a voluntary breeder health surveillance program, the National Poultry Improvement Plan (NPIP). This program has been successful in eliminating certain egg-transmitted diseases, such as *Salmonella pullorum*, *Salmonella gallinarium*, *Mycoplasma gallisepticum*, and *Mycoplasma synoviae* from breeding stock. Elimination of exotic and egg-transmitted diseases along with controlled exposure of other diseases through live vaccine use has resulted in successful field control of mild endemic respiratory diseases. Preventive medications such as coccidiostats and growth promotants in the feed have assisted in control of endemic enteric pathogens.

The strategies used in control of respiratory and enteric disease have been largely successful for the past 30 yr. Although there are many factors that contributed to this success, three distinct factors are noteworthy. First, single-age farms with all-in/all-out placements reduce cycling of pathogens between different age broilers. This methodology also allows environmental inactivation of some pathogens when adequate flock downtime of 12 d or greater is practiced. Second,

Received for publication August 3, 1997.
Accepted for publication March 2, 1998.
[1]To whom correspondence should be addressed.

Abbreviation Key: Conn = Connecticut strain; HPAI = highly pathogenic avian influenza; IB = infectious bronchitis; ILT = infectious laryngotracheitis; ND = Newcastle disease; NPIP = National Poultry Improvement Plan; Mass = Massachusetts strain; VNND = velogenic neurotropic Newcastle disease; VVND = velogenic viscerotropic Newcastle disease.

continuous genetic selection has increased weight for age each year by 45 to 65 g. This increase in weight equates to 0.5 to 0.75 d faster movement to the market each year. This cumulative effect allows birds to reach market weight faster, which results in less time for disease exposure or expression. Third, transition from open water systems to closed nipple water systems has significantly reduced poultry house litter moisture and reduced the reservoir for some disease-causing organisms.

RESPIRATORY DISEASE CONTROL

Newcastle disease (ND) and infectious bronchitis (IB) are the most common respiratory diseases of chickens. Infectious laryngotracheitis (ILT) occurs on a sporadic basis and is generally limited geographically. All three diseases are caused by viruses. There are no economical treatments for such virus infections, but avirulent virus in modified live vaccines are used as a method of prevention in chickens. Industry requirements for practical respiratory disease vaccines includes low cost, convenient application, good efficacy, and wide safety margins. Vaccine companies in the U.S. are strictly monitored by USDA, Veterinary Biologics, and produce a wide variety of quality vaccines.

The principles used in effective broiler vaccination are no different from those used by Louis Pasteur in 1880. An attenuated virus (modified-live) or a mild field strain are used to produce a subclinical infection or a mild form of the disease. Optionally, the vaccine virus spreads from bird-to-bird and stimulates protective antibodies such as IgG in the blood stream and IgA on the mucous membranes. Reinfection of an immunized chicken stimulates an anamnestic (memory) response leading to rapid production of specific antibodies against the invading virus. Ideally, vaccine viruses replicate in specific target tissues and produce local protection, such as IB virus replicating in and protecting the respiratory system. As added early protection, killed vaccines are used in breeders to induce high levels of maternal antibodies that are passed through the yolk to the chick. Such passive immunity disappears quickly and can interfere with early immunization effectiveness, i.e., high passive immunity to ND virus can prevent active immune response to day-of-age vaccination with ND vaccine. Therefore, many breeder vaccination programs may have a target of lower levels of passive immunity for ND to allow an immunologic response to vaccination at 1 d of age. Vaccination for IB and ILT are only minimally affected by passive immunity at preventing clinical disease in the field.

Vaccination programs for broilers are set up according to climate, geographic density of poultry farms, market age, and disease challenges. Market age for chickens can vary from 30 to 60 d depending on the size of chicken desired. Routinely, broilers are vaccinated against respiratory pathogens at 1 d of age in the hatchery with a combined ND and IB virus vaccine. An additional vaccination may be applied at 12 to 18 d of age for chickens maintained for longer growout periods. This additional vaccination allows for raising broilers in areas with high incidence of disease. In rare cases, a third vaccination at 30 d of age or over may be used in male roosters that are marketed at 65 d of age. Newcastle disease and IB modified-live vaccines are available in lyophilized or frozen form. Lyophilized vaccines are more convenient for use in the field.

Newcastle disease viruses causing disease in the U.S. are of low virulence. They primarily predispose birds to secondary bacterial infections and cause production losses. There have been VVND and VNND sporadically diagnosed and have been swiftly eradicated from commercial broilers in the U.S. Because all ND viruses are a single serotype, commercially available ND vaccines give protection against all strains found in the U.S. The lentogenic strains of ND viruses (B_1B_1 and B_1 Lasota) are used as vaccines.

Unlike ND, IB is caused by a group of structurally similar, but antigenically heterogeneous serotypes of an avian coronavirus. Infectious Bronchitis is important because it can cause poor feed conversion and reduced weight gains along with secondary respiratory infections that result in processing plant condemnations as a result of septicemia/toxemia and airsacculitis. Different serotypes of IB vaccines are generally not completely cross protective. Massachusetts (Mass) and Connecticut (Conn) serotypes of IB viruses are routinely administered together with ND vaccine. These IB serotypes do not provide full protection against other IB serotypes such as JMK, Ark-99, Ark-DPI, or 072. These IB virus strains in attenuated forms are used in conjunction with Mass and Conn vaccines on a regional basis.

Proper application is critical to a successful vaccination program. With *in ovo* vaccination for Marek's disease, chicks are never individually handled for vaccination at the hatchery and administration of vaccines against respiratory viruses in the hatchery or the field is by mass application. Hatched chicks are mechanically segregated from egg shells, counted, placed in shipping boxes, and vaccinated automatically for ND and IB via a spray cabinet on the conveyer line. Spray cabinets should be monitored daily for vaccine dose volume, spray pattern, and machine sanitation. Field vaccination can be achieved by a pump or proportioner attached to the waterline for mass water vaccination. Vaccination should be monitored to prevent less than desired results. Vaccines pumped directly into an empty nipple drinker waterline, which can be lowered to water-deprived chicks, is better than vaccine application through an in-line proportioner. With the proportioner application, a concentrated mixture of vaccine is applied at the rate of one ounce to each passing gallon of water. Newcastle disease vaccine stays well dispersed in the mixture, but IB vaccine can stratify in the bucket resulting in uneven IB vaccine delivery throughout the waterline. A nontoxic, visual dye included in the vaccine mixture should be used for monitoring adequate vaccine application. Commercial dyes that stain the tongue of the chicken are ideal. Take a count of birds and check for stained tongues at four places down the line to assess successful application percentages.

An alternative method for vaccine application is through an enclosed bag that drips the concentrated vaccine at a steady rate directly into the nipple waterline via a tube plugged into the waterlines. The bag is suspended between the waterlines. Another method of application is mass spray through a mobile, backpack sprayer. New sprayers of advanced design are self-contained and deliver a mixture of water and vaccine for wall-to-wall application as the operator travels the center of the house. Success for all vaccination methods is dependent on following the correct protocols. Vaccines should be administered at one full dose per chicken.

Vaccination programs should be routinely monitored for efficacy. If disease problems occur, vaccine application should be the first area to assess. Second, chickens from several flocks should be challenged in a laboratory to determine protection. A respiratory virus challenge model consists of challenging with a standard ND or IB virus using serotypes similar to those in the vaccine. Such studies should be done in isolation facilities. Five days after challenge, virus isolation should be attempted from the tracheas of the challenged birds. Lack of homologous virus recovery indicates the chickens were protected against that specific type of virus. Unvaccinated groups of age-matched chickens should be included as controls. Third, virus isolation should be attempted from field birds or vaccinated sentinel birds on the fifth day after placement. Virus isolation allows determination of virus subtypes or strains not protected by the current vaccine.

Serologic assessment of samples collected at market age can yield information about problems with vaccines or vaccination strategies. Well performing flocks with minimal disease problems typically have low titers on ELISA serologic assessment for ND or IB virus infections. High ND and low IB virus antibody titers indicate a field ND virus challenge. Low ND and high IB virus antibody titers indicates an IB virus challenge. Both ND and IB virus antibody titers high at market age on ELISA could represent vaccine virus “roll or cycling.” Cycling occurs when a flock does not recover from the clinical reaction to the vaccine, and the vaccine virus increases in pathogenicity as a result of bird-to-bird spread. Common factors that can impact vaccination program efficacy include vaccine dosage, vaccine strain selection, application method, seasonal weather, *Mycoplasma* infection status, and immune system function. Current vaccine programs for ND and IB are inexpensive and efficacious. However, current regional trends indicate increasing incidence of respiratory disease and increasing processing plant condemnations of chicken carcasses with airsacculitis. Infectious bronchitis is considered the major cause. The cause of IB, a coronavirus, has a high mutation rate resulting in emergence of new serotypes. New serotypes may evolve and spread unchecked by immunity induced by commercially available vaccines. Accurate diagnoses and serotyping are needed to confirm these developments.

Infectious laryngotracheitis vaccines are commercially available in two forms, tissue culture or chicken embryo origin. The latter is the more immunogenic vaccine and is used to immunize broilers at risk in ILT endemic areas. Application method is critical for success and oral immunization via water application provides necessary full flock coverage. To ensure that all chickens are exposed to the vaccine, flocks may be vaccinated twice in succession.

A new generation of vaccines against respiratory viruses are in development. Vectored vaccines, gene-deleted vaccines, and vaccines with immunomodulators will be marketed soon. Some modified-live vaccines have caused problems, from misapplication resulting in production of disease indistinguishable from disease caused by field virus. Efficacy and economics will dictate success of the new generation of disease control products.

ENTERIC DISEASE CONTROL

Optional enteric health of growing chickens is imperative to maximal individual bird performance and to achieve financial success in the poultry industry. The essence of the broiler business is turning feed stuffs into consumable meat products. The purpose of the enteric system is to break down feed stuffs into basic components for transport and utilization in maintenance and growth of the bird. Any physical, chemical, or biologic disturbance of this process can result in enteric disease.

Annual genetic improvements results in two points better feed conversion and 0.1% higher greater eviscerated yield. The results are big, economical, and fast growing chickens. Modern chickens are hyperphagic and do not tolerate lack of feed even for short periods of time. A potentially common problem, out of feed, can disrupt the best enteric disease control strategy.

The incidence of enteric disease has decreased as general poultry husbandry, nutrition, feed quality, and veterinary surveillance programs have improved. As the poultry industry consolidates into larger and fewer companies, more sophisticated programs for live production are employed as more technical resources become available. Although sporadic enteric diseases still occurs on certain farms or geographic localities, they tend to be single company limited and the result of specific program decisions.

Enteric diseases that have pathognomic or specific gross lesions and clinical signs (i.e., coccidiosis, necrotic enteritis, etc.) are rapidly diagnosed and treated. More subtle conditions are given tentative field diagnoses based on available limited information. Such enteric problems are usually transient and tend to resolve as feed stuffs, bird populations, weather conditions, or drug programs change.

Potential causes of enteric disease needing control strategies, in order of prevalence, are coccidiosis, feedborne toxins, bacteria, and viruses. Although many agents or chemicals have been tested and found detrimental to the intestinal tract, the present discussion will be limited to the most commonly encountered conditions.

Control strategies for enteric diseases are almost exclusively delivered via the feed. Controlled exposure and development of local intestinal immunity are the cornerstone of coccidiostat and growth promotant drug programs.

Coccidia are ubiquitous within poultry houses in the U.S., on either new or built-up litter. Success of commonly used chemotherapeutics, which includes polyether ionophores, is dependent on survival and passage of some coccidial oocysts to enable the intestinal mucosa to mount an effective intestinal immunologic response. The intracellular stage of the organism disrupts the intestinal epithelium and causes transient malabsorption. Whether primary or secondary, coccidiosis is a common cause of enteric disease and transient growth depression. However, chickens recover quickly because they have the capacity for compensatory gain. Stable challenge levels of coccidia can be achieved in most broiler growing areas, therefore acting as a controlled-exposure vaccine. Companies that require yellow skin coloring on poultry products for regional marketing programs must have more strict coccidial control programs. Inexpensive carotenoid pigments fed in feed are deposited in the skin to produce the desired yellow pigmentation. However, coccidiosis can significantly lower plasma carotenoid levels and subsequently reduces flock skin color scores.

Coccidiostat programs are based on an individual broiler company's technical requirements. This requirement is driven by bird market age, regional weather patterns, immunological response of broiler breeders, and skin color requirements. Poultry house challenge levels of coccidia are driven by moisture levels that sporulate the oocyst. Closed houses in the winter or high humidity in the summer result in the highest challenge levels of oocysts. Nipple water systems have contributed to improved coccidial control by improving litter quality with drier and less caked litter. Coccidiostats (ionophores or other drugs) are rotated throughout the year based on environmental factors in order to achieve desired coccidial control.

The current industry trend is to use fewer chemical coccidiostats, lengthen withdrawal periods and use the lowest efficacious level per ton of feed. Controlled exposure is the strategy of coccidiostat administration. However, a balance must be achieved between sufficient coccidial numbers to produce an effective immune response, and low enough coccidial numbers to prevent reduced performance and economic losses. Flocks should be routinely examined for coccidia to assess exposure levels.

Feedborne toxins in various feedstuffs can cause enteric disease. The most common examples are mycotoxins, biogenic amines, or ingredient impurities. Mycotoxins are produced by molds and fungi, and are found in cereal grains and soybean meal. Biogenic amines are protein breakdown products and can be found in rendered meat products such as poultry, meat, bone, and fish meal. Rancid fat or metal impurities can be additional causes of enteric disease.

Feed toxin problems are often traced back to specific suppliers. Quality assurance standards are critical in establishing minimal requirements accepted for specific ingredients. This control strategy requires laboratory analysis on a routine basis for all shipments of ingredient.

Feedborne toxins at detrimental levels result in poor performance through depression of growth rates and reduced feed conversion. Clinical signs and lesions may include stunting, pale skin color, ventricular (gizzard) erosion, and proventriculitis. Field problems from feedborne toxins tend to be sporadic as multiple company buyers simultaneously tap the same supply of a problem feed stuff.

The most clinically dramatic bacterial enteric disease is necrotic enteritis caused by *Clostridium perfringens.* This bacterium is ubiquitous in poultry house litter, but fortunately, commercial broilers are fed non-absorbed, antimicrobial products in the feed to control *C. perfringens* and other species. Necrotic enteritis, as a clinical disease, is infrequent, but may be induced by secondary predisposing factors, such as toxic feed ingredients or coccidiosis. Sporadic necrotic enteritis has resulted from failure of protection by synthetic coccidiostat drugs. In addition, poor quality wheat at levels above 50% of corn replacement can increase susceptibility to necrotic enteritis due to water soluble nonstarch polysaccharide components and increased intestinal viscosity.

Growth promotants are systematically rotated over a year's feeding schedule and multiple growth promotants may also be used in a single growout cycle. One product may be used in the starter ration and another growth promotant in subsequent feeds.

Confirmed diagnosis of viral enteritis in chickens is rare. The incidence tends to be geographic and transient and no prevention strategies are available. Current research may result in development of new detection tests for more accurate and rapid diagnosis of viral enteritis.

CONCLUDING REMARKS

Prevention strategies for respiratory and enteric disease have been largely successful for the last 30 yr. As the leading integrated producer of meat in the world, the broiler industry has profited from rapid growth in both efficient production and increased consumer demand.

Density of broiler houses have increased geographically as the industry has increased five times in size since the 1960s. The broiler growing areas of the southeast are near continuous from the Delmarva peninsula to Arkansas. Potential for spread of endemic diseases through large naive populations of birds is a real threat. Exotic and egg transmitted diseases must also be controlled.

As the broiler industry matures and continues a long stretch of unbroken profitability, investor expectations are focused on quarterly earnings. Adequate poultry meat stock are available for the U.S. and excess production is exported. Prices reflect a close supply: demand ratio. There is intense pressure to keep live production cost as low as possible.

The individuals responsible for establishing the broiler industry have passed on the companies to second and third generation operators. The industry attitudes have changed from a pioneering spirit to a modern day business run for profit. Successful strategies should not be shortcut or changed until new strategies are systematically tested over time for efficacy in preventing respiratory and enteric diseases.

Increased governmental regulation has slowed approval of new drugs and vaccines. Environmental issues must be addressed for the future in high density poultry house growing areas. New strategies will evolve, but they will be more expensive and require more technical application and monitoring for success.